JOURNAL

OF

THE FRANKLIN INSTITUTE,

OF THE

State of Pennsylvania,

AND

AMERICAN REPERTORY.

MARCH, 1847.

## CIVIL ENGINEERING.

*Annual Report of the Canal Commissioners of Pennsylvania, transmitted to the Governor in pursuance of Law, for the Financial Year ending November 30th,* 1846.

The following report of the operations upon the canals and railroads of the commonwealth, is respectfully presented by the Canal Commissioners of Pennsylvania, embracing the fiscal year commencing December 1, 1845, and ending November 30, 1846.

The receipts and expenditures upon the public works, during the fiscal year, have been as follows:—

*Receipts.*

| | | |
|---|---|---|
| For motive power charges and for use of State trucks on the Philadelphia and Columbia railway, including fines, and for old materials sold, | $ 250,757·90 | |
| For motive power charges and for use of State trucks on the Allegheny Portage railway, including fines, and for old materials sold, | 140,639·75 | |
| For tolls on the Philadelphia and Columbia railway, | 223,792·73 | |
| For tolls on the Allegheny Portage railroad, | 46,038·04 | |
| | | $ 661,228·42 |

| | | |
|---|---|---|
| Amount brought forward, . . . | | $ 661,228·42 |
| For tolls on the main line of canal, including collections at out-let locks, bridges, and aqueducts; also rents, fines, and old materials sold, | 335,809·56 | |
| For tolls, rents, fines, &c., on the Delaware division, | 146,321·56 | |
| For tolls, rents, fines, &c., on the Susquehanna, and North and West Branch divisions, | 152,135·22 | |
| | | 634,266·34 |
| Total gross receipts, | | $ 1,295,494·76 |

*Expenditures.*

| | | |
|---|---|---|
| For maintaining motive power on the Philadelphia and Columbia railway, including the repair and management of State trucks, | $ 157,846·23 | |
| For maintaining motive power on the Allegheny Portage railway, including repair and management of State trucks, | 103,260·62 | |
| For repairs on the Philadelphia and Columbia railway, | 58,702·24 | |
| For repairs on the Allegheny Portage railway, | 25,567·45 | |
| For repairs on the main line of canal, | 140,855·92 | |
| For repairs on the Delaware division, | 43,554·53 | |
| For repairs on the Susquehanna, and North and West Branch divisions, | 115,063·64 | |
| For compensation of collectors, weigh-masters, inspectors of cargoes, including house rent, stationery, and incidental expenses of their offices, | 32,073·68 | |
| For compensation of lock-keepers, | 33,006·60 | |
| | | 709,930·91 |
| Receipts over expenditures, | | $ 585,563·85 |

From the above sum of $585,563·85 may be deducted $5,041·72, the amount expended for pay of Canal Commissioners, secretary, clerk hire, messenger, stationery, postage, and incidental expenses of their office, leaving $580,522·13 as the net revenue produced by the canals and railroads of the commonwealth, for the year ending November 30, 1846.

The foregoing synopsis of receipts and expenditures, embraces the cost of maintaining the motive power on the Philadelphia and Columbia, and Allegheny Portage railroads; the cost of repair, ordinary and extraordinary, upon the canals and railroads of the State, as also the compensation of all the officers and agents employed on them during the year; the payments for work and labor done at the Eastern

reservoir. The sums paid for damages, under general and special acts of Assembly, and the balance of a former appropriation for the purchase of new trucks, which was expended for that object, are not embraced in the foregoing statement of receipts and expenditures for the year 1846, as they are not considered as belonging to the repairs and management of the public works for any *one* fiscal year, but are brought into view in another part of this report.

It may be proper to state here, that on comparing the foregoing statement with the actual receipts from, and payments to, internal improvements, as given in the report of the State Treasurer, for the fiscal year ending on the 30th November, 1846, a considerable variance may appear, which is readily accounted for by the fact that the transactions of the officers, (residing in parts of the State remote from the seat of government,) at the Treasury, cannot be brought up to the last day of the fiscal year, on which the balances are all struck at that department; consequently, in the statement of the Treasurer, a portion of the receipts, which properly belong to the past year, but which, although collected in that year, were not paid in, nor credited until after the 30th day of November, will appear as receipts of the fiscal year ending on the 30th day of November, 1846. The same may be said of a portion of the receipts of the year just closed, which will be carried in this way to the ensuing year. The payments at the Treasury are also charged, as of the date on which the disbursing officer draws the money, to be thereafter paid out and accounted for by him, and do not, therefore, show the exact transactions in the way of expenditures within the year. The Canal Commissioners, however, in the foregoing statement, have not omitted any thing actually expended during the fiscal year, whether paid and settled before the close of the year or not. Nor have they included any thing in the receipts which did not come into the hands of the collecting officers during the same period.

In their report of last year, the Canal Commissioners estimated the gross receipts, for the year just closed, at one million two hundred and seventy-five thousand dollars, and in this respect their anticipations have been more than realized; but they regret to state, that the freshet of March last, (unprecedented within the last sixty years,) sweeping, as it did, entirely over a great portion of our canals, and carrying upon the surface of the water immense masses of heavy ice, produced the necessity of very heavy expenditures for extraordinary repairs, as well as much detention in the opening of navigation upon the several lines of canal. In the tabular statement attached to this report, numbered *one*, the character and cost of the repairs are stated, distinguishing between those of an ordinary character, and those rendered necessary by floods and other casualties.

The operations on the public works, with suggestions in reference to them for the ensuing year, will be noticed in order, commencing with the Main Line.

### *Philadelphia and Columbia Railway.*

From the report of the superintendent of this work, it will be perceived that the operations in the motive power department have been

conducted with much regularity and despatch, and that no casualty of a serious character has occurred.

The reduced expenditure, in proportion to the amount of tonnage, number of cars, and passengers transported over the road, is a gratifying evidence of the skill and integrity of the officer who has been charged with its management during the three last years.

The machinery upon the road is represented by the superintendent in excellent condition; extensive rebuilding and repairing of the engines having been done during the past season. The power of the stationary engine, at the head of the Schuylkill inclined plane, has been increased by the substitution of new and enlarged boilers for the old ones, which were worn out, and other important improvements. The repairs upon the road have been more than ordinarily expensive during the past season, owing to the rapid wear of the rails, and the heavy burthens carried over it. It has been found necessary to insert *forty tons* of new rail, which cost, at the works at Danville, *eighty dollars* per ton. When it was ascertained by the Board that this price was demanded for the new rails, they would have deferred ordering them at the time, indulging the hope that they might be subsequently obtained at a lower rate; but the condition of the road, and the absolute necessity of immediately supplying the place of old rails with new ones, on many parts of it, to maintain it in order for transporting freight and passengers safely, left the Board no alternative but to direct the superintendent to make the purchase at what they considered an extravagant price.

As the condition of the road is such as to require a considerable quantity of new rail every succeeding year, it is suggested that means should be placed at the disposal of the Board, so that contracts for iron may be made some time in advance of the period when it becomes necessary to use it, and the commonwealth be saved the necessity of paying more than this article should cost, in an emergency such as has been noticed.

That part of the railway between White Hall Station (eleven miles from Philadelphia,) and Columbia, is generally in reasonably good condition. From the head of the Schuylkill inclined plane to White Hall station, the whole travel and tonnage has, for several years, passed upon a single track, and it is, consequently, difficult and expensive to keep in repair. It will be remembered that the superintendent, in his report last year, submitted an estimate for an additional track upon this portion of the road, amounting to fifty-eight thousand dollars, and the Board concurred in recommending the measure to the attention of the Legislature. In his report of this year, the same officer has submitted an estimate for the same object, amounting to sixty-three thousand three hundred and ninety-five dollars; the difference between the former and present estimate, being made up in the increased price of iron now demanded over what it could have been purchased for in 1845.

In reference to this subject, the following extract from the report of the superintendent is respectfully commended to the attention of the Legislature, as containing the views of the Board, viz:—"It is cer-

tainly a source of regret that an appropriation was not made last winter towards an object of so much importance, as the situation of the South track is now such as renders the renewal of a portion of it imperative." It is hoped that the Legislature will no longer postpone (by withholding the necessary appropriation) the commencement of a work which is becoming indispensable from the increasing business upon this great thoroughfare. In the estimate submitted for the repair of the Philadelphia and Columbia railway for the year 1847, it will be seen that the sum required for that object is considerably larger than the amount expended during any one of the three preceding years; this results from the necessity of procuring and inserting new rails, and extensive repairs being indispensably required at the Coatesville viaduct and other mechanical structures. For more minute details of the operations upon this road, as also for the different items of estimated repairs, the Board respectfully refer to the report of the superintendent upon the road.

### *Allegheny Portage Railroad.*

This link in the main line of the State improvements was opened for use about the middle of March, and the business regularly conducted upon it throughout the season, with such interruptions only as resulted from a scarcity of trucks, at times, for all the section boats offering, and such as were caused by extraordinary floods and land slides upon the road. The locomotives and machinery are represented as in good condition, with the exception of such of the stationary engines as will require their foundations rebuilt during the ensuing winter. These repairs to the foundations are necessary, as well to conduct the business safely by the use of hemp ropes, (as has been the case heretofore,) but are essentially so, in order to adapt the machinery to the use of wire ropes, which are now found to be manifestly superior in point of safety and economy to any heretofore used.

In proportion to the tonnage passed upon this road, the expenses of maintaining the motive power have been less for the year 1846, than at any former period.

These expenses, it is confidently believed, may be still further reduced by substituting locomotives on most of the levels where horse power has heretofore been used, and by the employment of wire ropes upon all the planes. These improvements have been directed to be made, and in order to supply the motive power, it is designed to remove from the Philadelphia and Columbia railway to the Alle gheny portage railway, such of the locomotives as can be spared from the former, when *two* new ones, which the superintendent of that road has been instructed to contract for, have been delivered.

From the report of the superintendent of motive power, it will be seen that an additional number of trucks will be required for the business of next year, to accommodate and pass without detention the section boats that navigate the main line. This system of transportation is found from experience to be very severe on the railways,

wearing out and crushing the rail ends, as well as deranging the track to a much greater extent than the use of ordinary cars.

The Board would respectfully leave to the Legislature the decision of the question, whether, under all the circumstances, this mode of transportation should be further encouraged, and the facilities increased beyond the provision already made for it by the commonwealth.

The cost of repairs on the Allegheny Portage railway during the past year, although less than that of the preceding year, has been considerably enhanced by the increased business upon it, and the remarkably heavy rains which occurred several times during the season. The superintendent states that *three* several times the operations upon the road were for a time entirely suspended in consequence of the hill sides giving way at different points, and large bodies of earth and stone covering the track, and in some instances carrying with it the whole road at these points. The frequent heavy rains have done considerable damage by filling up the ditches and culverts, besides causing the streams in the vicinity of the road to pass over it in several places and sweep out the whole embankment, road bed, blocks, &c. All these injuries were promptly and permanently repaired with the least possible delay practicable under the circumstances. The condition of the tracks upon the inclined planes has become such from the decay of the wooden superstructure and the wear of the flat rails, that the time has arrived when a commencement must be made to relay them with T rails. To postpone any longer this improvement, is to embarrass and retard transportation over the road, and at the same time incur more risk of accidents, as well as increased expenditures for the motive power.

To enter into detail in reference to this work, would swell this report beyond reasonable limits, and the Canal Commissioners therefore respectfully refer for more minute information to the accompanying report of the superintendent of the road.

### *Main Line of Canal.*

The main line, it was designed by the Board should be ready for navigation by the 17th of March last, and the ordinary repairs had been made during the preceding winter with the view of opening it at that time; but that intention was frustrated by the unprecedented flood which has been hereinbefore alluded to, and which delayed the opening of the navigation until near the middle of April. After the opening of the navigation some slight interruptions to it occurred, occasioned by breaches at various points on the line, and lastly by a high flood in the Juniata river near the close of the season.

The nature and extent of the damage to the main line, as also that sustained on the other divisions by the great spring flood, was, immediately after its occurrence, communicated to both branches of the Legislature in a special report from the Board, and it has not been deemed necessary to recapitulate it on the present occasion.

In addition to the ordinary repairs required in clearing out the canal, repairing and strengthening the banks, &c., much of an extraor-

dinary character, such as rebuilding of the mechanical structures, has been required during the past season, among the heaviest of which may be enumerated—two new aqueducts, rebuilding one lock and making water way and feeder around the guard lock at the Clark's Ferry dam, all on the Eastern division.

### *Clark's Ferry Bridge.*

This important structure was seriously injured by the flood in March last, before referred to—two of the piers having been partially cut down by the heavy floating ice, and two spans, or about one-fifth part of the superstructure, carried away, besides considerable injury to the arch timbers of the other spans. The officer in charge of the line had been instructed, and was making arrangements, to rebuild and repair the injured portion of this work, but before any considerable amount of work had been done to it, the remaining portion of the superstructure unfortunately caught fire from sparks blown upon it from the engine on the boat engaged in towing the canal boats across the pool of the dam. After this disaster, the board were strongly inclined to adopt the wire suspension plan in the reconstruction of this bridge, but upon inquiry they ascertained that the cost would be so much beyond that of a good wooden superstructure, that under all the circumstances, and in view of the means at their command, they concluded to rebuild it of wood upon the arch and truss plan, modifying, and, as they believe, improving on the plan of the old superstructure. At the same time, they deemed it prudent to raise the whole work three feet above the original height, to secure it against danger from a flood similar to that which caused the injury, which required a corresponding increase in the height of the masonry of the piers and abutments, as well as the taking down the same height of old masonry before commencing, in order to put in the new skew-backs at the proper points for the increased elevation of the bridge, being equivalent to *six* feet in height of masonry on all the piers and abutments. The ice breakers were also raised *seven* feet above their former height, to guard against injury from floods in future.

The Board did not hesitate to adopt the alternative of rebuilding *at once*, as the best calculated to promote the interest of the commonwealth, as well as to facilitate and retain the trade and transportation upon the public improvements. The expense attending the towing of canal boats across the river at Clark's ferry, would amount annually to more than three times the interest on the cost of rebuilding the bridge, without taking into view the tolls received for travel upon it, amounting to about an average of two thousand dollars annually. This work will have cost for its reconstruction, when completed, the sum of thirty-six thousand nine hundred and seventy-two dollars and fifty cents, of which sum, twenty-two thousand three hundred and seventy-five dollars and eighty-nine cents was expended and paid before the close of the fiscal year. Ten thousand dollars of the aggregate cost of rebuilding was rendered necessary by injury from the flood, and provided for in the appropriation for that object, made by

the acts of the 1st and 20th of April, 1846. The balance of the aggregate cost was occasioned by the fire. This bridge was so far advanced towards completion, as to be opened for travel on one of its road-ways on the second day of the present month, and the commonwealth has since that date been receiving toll for its use, as heretofore. Upon the *Juniata division*, the largest expense incurred in extraordinary repairs, was for the rebuilding of the Shaver's Ford aqueduct, and the out-let lock at Lewistown. The Shaver's Ford aqueduct was destroyed by fire in the month of September, 1845, and no doubt is now entertained of its having been fired by an incendiary. Its place was supplied by the erection of a temporary trunk, supported by trestles, which answered for the purpose of keeping up the navigation during the remainder of that season.

During the fiscal year just closed, it has been replaced by a new and substantial structure, dispensing with the roof, and increasing the width of trunk from sixteen to eighteen feet, and costing the sum of ten thousand five hundred and forty dollars, being five hundred and forty dollars more than was estimated for it by the Board, in their last annual report. This increased cost over the estimate is attributable to the unexpected severity of the weather during the last winter, which prevented the execution of the work as advantageously and economically as was anticipated at the time it was made. The whole of this work had to be done during the winter months, and it was faithfully executed and completed so as to be ready for navigation over it on the 15th of last March. The out-let lock at Lewistown, constructed originally of crib work, and which had become so much decayed as to be entirely unfit for use, was rebuilt during the past summer, at a cost of two thousand one hundred and fifty dollars and seventy-five cents. This improvement will add much to the facility for shipping at this point, which, without the advantage of the outlet, was very much confined and embarrassed.

Upon the *Western division*, between Johnstown and Pittsburg, a considerable amount of extraordinary expenditure has been required in repairing breaches occasioned by floods during the summer, as well as in repairing the injury done to many parts of the work, by the breaking up of the ice last winter. In addition to the current repairs required to keep up the navigation on this division, the superstructures of three aqueducts were renewed last winter, as also extensive repairs to the one over the Allegheny river, near Freeport. A supply of material is now on hand for the thorough and complete repair of this work during the ensuing winter. The crib work protections at dams Nos. 2 and 3, on this division, having become much decayed, and having sustained severe injury from the ice floods last spring, were partially carried away by the heavy freshets during the summer. These have been replaced in a substantial and permanent manner.

### *Delaware Division.*

Arrangements had been made for an early opening of navigation on this division of the public works, but in consequence of the extensive

injury to the canal by the spring flood, it had to be delayed until about the middle of April, at which time it was resumed, and has been continued without further interruption throughout the season. The special report of the Board (already noticed,) to the last Legislature, relative to the damage done to the State works, caused by the flood in March last, will show that, in proportion to its length, this division of canal suffered more severely by that flood than any other portion of the State improvements. The prompt action of the Legislature in providing the necessary funds for its repair, together with the energy and perseverance of the supervisor, and those under his direction, in the discharge of their several duties, enabled the Board to have it placed in condition for resuming the navigation upon it at the time above stated. The annual current repairs to the canal banks, protecting them with rip-rap repairs to locks, aqueducts, waste weirs, &c, have all been attended to during the summer, and the canal is now in excellent order for an early resumption of navigation on it next spring. This division of the Pennsylvania improvements, during the fiscal year just closed, has yielded a revenue nearly equal to the interest upon two millions of dollars, after paying all the current repairs and other expenses, as well as the extensive repairs rendered necessary by the freshet of last spring.

In pursuance of the act of 20th April last, authorizing, under certain conditions, the construction of an out-let lock at Well's Falls, the Board advertised for proposals for the loan authorized by said act, to be received at their office until the 10th day of July last; no offer to take the loan, however, was received, and the Canal Commissioners were therefore under the necessity of postponing any further steps towards carrying out the object of the enactment.

### *Susquehanna and North and West Branch Divisions.*

The opening of navigation upon the Susquehanna division was delayed until late in the month of May, in consequence of the great injury it sustained by the spring flood and subsequent freshets in the river. The West Branch division was ready for navigation in April, and the North Branch early in the month of May, but as these two branches were of little use until the communication with the main line, through the Susquehanna division, was complete; it was near the last of May before the navigation throughout could be said to be open. In addition to the repair of the damages to these lines, and the ordinary current repairs, a large expenditure has necessarily been made in the reconstruction of the superstructures of four aqueducts, and thoroughly tightening and securing the Shamokin and Nanticoke dams.

The Shamokin dam had been repaired by contract for a considerable portion of its length, and the work was suspended in 1842. During the past season the remaining portion of it, 1154 feet in length, has been thoroughly re-covered on the upper slope, and, it is believed, made sufficiently tight to supply the canal with water without a resort to coffer dams during the low stages of water, as has been the case

for many years past. At the Nanticoke dam a substantial crib work has been placed below the old dam, extending from the canal side of the river some distance beyond the angle, and about one hundred feet more than half its length. The sickness which prevailed among the laborers at this work prevented its completion; but it is believed that the portion of the dam most likely to sustain injury from the spring freshets has been secured, and the remaining portion can be protected during the next summer so as to render it beyond danger for years to come. The accompanying tabular statements, numbered 1, 2, 3, and 4, are referred to as exhibiting in detail the cost of the repairs made on the several lines of improvement, which is deduced from the reports of the several supervisors having them in charge—an estimate of the sum necessary for that object during the fiscal year 1847—a statement of the damages awarded by the Board under general and special laws, and the tonnage shipped upon the several lines of improvement.

In accordance with the provisions of the act of the 31st January, 1846, the Board received proposals for completing the Eastern, and progressing with the work at the Western, reservoir, to the amount appropriated thereto.

The Eastern reservoir being nearest to completion, and of the most pressing necessity, was allotted to H. L. Patterson, he being the lowest bidder, and a contract was entered into with him according to the provisions of the act, for completing the work, which has been prosecuted by him throughout the season with considerable energy, and the sum of fourteen thousand six hundred and eighty-one dollars and eighty-four cents of the amount appropriated thereto, has been drawn and expended in carrying it on. The progress of this work has been delayed by frequent freshets in the South Branch of the Juniata, but no doubt is entertained of its completion in time to be made available before the next season of low water. The amount appropriated for this work will be sufficient for its accomplishment. The large expenditures required for repairing the damage by the last spring's flood to our public works, induced the Board to defer placing the work at the Western reservoir under contract at the time they had intended, and no measures other than receiving proposals for it have been taken for its prosecution. Although some delay and embarrassments have occurred to the business upon the main line during the past season, occasioned by a scarcity of water in the canal, yet it has not been the case to so great an extent as during several preceding years.

In obedience to the requirements of the act of the 10th of April, 1846, relating to the assessment of damages on the Erie extension, the Canal Commissioners visited that work in the month of August last, and made a personal examination of the injured premises, in all cases where applications for damage had been laid before them. These claims have not yet all been acted upon by the Board; some of them having been delayed to afford the claimants opportunity to collect and send on additional testimony, which they were anxious to do. They will all, however, be determined as soon as practicable, and a

report of the decision in each case will be certified in accordance with the provisions of the act above recited.

It is a matter of regret that there are some meritorious claims in the vicinity of the Conneaut reservoir, which the Board found had been acted upon before the damage caused by the completion of that work had been fully developed, and awards made, which do not afford adequate remuneration to the claimants; but inasmuch as the act referred to, did not confer any authority on the Board to review such cases, they were obliged to decline entertaining all applications for *review* which were presented to them.

The appropriation for rebuilding and repairing the public and farm bridges, made in 1844, has all been expended for that object; and during the last season several cases occurred which rendered it necessary, under existing laws, for the Board to direct them to be repaired and paid for out of the ordinary repair fund. It is hoped that the Legislature will no longer defer a decision of the vexed question, which has so often been presented to them, whether these bridges over the canal, erected for the accommodation of individuals and communities, shall be kept up by such individuals and communities, or by and at the expense of the commonwealth? If it is determined that they shall be maintained by the latter, the sum of fifteen thousand and eighty-five dollars, in addition to the amount estimated as necessary for ordinary repairs during the fiscal year, 1847, will be required for that purpose. The balance of the appropriation made by the act of 17th February, 1845, for the purchase of new trucks, which remained unexpended at the date of the last annual report of the Board, has during the past year been all expended for that purpose.

Of the amount appropriated for the payment of damage on the canals and railroads of the State, by the 24th division of the 1st section of the act of the 20th April last, there have been warrants drawn for the sum of ten thousand four hundred and ninety-three dollars, up to this date, and it is believed, the balance will be ample to cover all the awards made prior to the passage of that act, which remain unpaid, and may be applied for prior to the 1st day of June next, to which it is alone applicable. Awards have been made by the Board, under general and special laws, during the fiscal year just closed, for damage on the public works, (exclusive of those on the Erie extension) amounting in the aggregate to the sum of twelve thousand six hundred and eighty-eight dollars, for the payment of which no appropriation has yet been provided. The amount awarded to each claimant will be seen in the accompanying statement, numbered 3. This sum will therefore require to be appropriated for that purpose.

The injuries to the public works of the State by malicious persons, are becoming of so frequent occurrence as to induce the Board to believe that some further provision by law, for bringing the perpetrators to justice, is required to prevent their recurrence. The burning of the Shaver's Ford aqueduct was, as has been stated, doubtless the work of an incendiary; and, during the past summer, the Board received such information as induces them to believe, that the perpetrator of this outrage could have been brought to trial and convicted for it, if a

suitable reward could have been given for his apprehension. The cutting of the rope on the Schuylkill inclined plane, on the night of the 6th of November last, was another act of malicious mischief, which, but for its timely discovery, might have resulted in the most disastrous consequences to the lives of the passengers on the road at that time.

It is a matter of regret that there was no means at the disposal of the Executive, or the Board, to offer as a suitable reward for the apprehension of these offenders. It is therefore respectfully suggested to the Legislature, as the best mode of preventing a recurrence of these dangerous offences, that a small contingent fund be placed at the disposal of the Executive, to be applied, under the direction of the Canal Commissioners, to defraying the expense of bringing the perpetrators of such offences to trial and punishment.

By reference to statement No. 2, accompanying this report, it will be seen that the estimated cost of repairs, ordinary and extraordinary, including the completion of the Clark's Ferry bridge, and the rebuilding and repairing of the public and farm bridges over the canals, amounts to the sum of $273,609·98, from which, if the sum of $50,000, appropriated by the act of 20th April last, for providing materials and repairs after the 1st December instant, be deducted, it will leave $223,609·98, as the sum required to be appropriated for maintaining the canals and railroads of the State in proper repair during the fiscal year ending on the 30th day of November, 1847. In addition to the last mentioned sum, an appropriation of $50,000 for the preparation of materials and for executing repairs after the 1st day of December next, should be made at the coming session of the Legislature; as also an appropriation of about $25,000 for the repair of breaches in the canals, or other casualties that might occur, and which can be much more economically repaired if the funds are already provided, than by having the work required for that purpose done on the credit of the State, and waiting the future action of the Legislature to provide for its payment.

In a former part of this report it has been shown that the whole amount expended, during the past fiscal year, for maintaining the motive power upon the two railroads of the commonwealth, repairs of the canals and railroads, ordinary and extraordinary, and compensation of all officers and agents, amounted in the aggregate to the sum of $709,930·91; of this sum, $111,515 was required for repairing the damage done by the extraordinary flood in March last, and the further sum of $12,375·89 in repairing the damage by fire at the Clark's Ferry bridge, as also the sum of $8300 in fitting up and maintaining steam power for towing the canal boats across the pool of the dam at that point: making an aggregate of $132,190·89, which could not be foreseen at the date of the last annual report of the Board. This deducted from the aggregate, the sum above stated, would leave the expenditures for ordinary objects but $577,740·02, which, deducted from $1,295,494·76, the gross receipts of the year, will leave as net revenue the sum of $717,754·74, to which sum may be added the amount of tolls which would have been received over and above the

actual gross receipts above stated, if the opening of the navigation had not been delayed by the damage from the flood last spring, for some six weeks later than could have been previously anticipated, which is at least $150,000, and it will give the sum of $867,754·74 as the amount which would have been realized as the net revenue of the year, had no greater difficulties and casualties occurred during the last, than were annually encountered for four or five preceding years. This statement is presented for the purpose of shewing, that if no extraordinary casualty should occur during the coming year, to increase the cost of repairs or interrupt the early opening of the navigation next spring, the net revenue which will be derived from the improvements of the State, may be reasonably estimated at the sum of $850,000, for the fiscal year ending on the 30th day of November, 1847.

In the appropriation bill of April 20, 1846, the usual contingent fund for breaches, &c., was omitted; and a large amount of extraordinary repairs of this character have been made during the past season, rendered necessary by frequent floods, land slides, breaches, and other casualties. These causes have operated to exhaust existing appropriations for repairs of the canals and railroads, and unless funds are immediately provided, the current repairs during the winter cannot be as promptly and economically made as they ought to be. It is therefore suggested to the Legislature, that of the amount estimated as necessary for the repairs of the canals and railroads for the year, 1847, the sum of thirty thousand dollars should be immediately appropriated.

WM. B. FOSTER, Jr.
J. HARTSHORNE,
JAMES BURNS,
*Canal Commissioners.*

CANAL COMMISSIONERS' OFFICE,
*Harrisburg, December* 31, 1846.

---

## *The Gauge Commission.*

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway gauges.

Continued from Page 93.

George Parker Bidder, Esq.*: Is in the immediate management of the lines in Norfolk, and the Peterborough line. From his connexion with Mr. Stephenson, has more or less information of the lines with which he is connected. With respect to the great increase of cost which Mr. Gooch says exists upon the narrow gauge lines for the locomotive power of the goods trains, the cost upon the London and Birmingham and the Grand Junction being double what it is upon the Great Western, is prepared to dispute that fact entirely; but, there

* The editor (of the Civ. Eng. and Arch. Jour.) has felt it his duty to append to this evidence some comments, which will be found in their proper places, inserted in brackets.

are circumstances which might affect that comparison as to the particular character of the goods trade. On one line it may be necessary to have trains which may have to pick up goods at different stations, so as not to carry the same load from the terminus, and at the same time to have the same engine power; and there may be a variety of other circumstances. For instance, on the Norfolk railway, at present, the connexion is not completed of the two railways at Norwich on account of a bridge of an original construction, a swing bridge; so that the fish is brought from Yarmouth to Norwich, then discharged, and carried across the river, then loaded again, and then brought to London, and those trucks go back light. Therefore if you were to take the actual cost of locomotive power for the goods there, you would have to charge two miles of locomotive power for one mile of effective traffic, and consequently, although the locomotive engines might be running at actually a less mileage than another line, yet in that sort of comparison, they might be made to appear to be working at a greater cost. Therefore, unless you have all the circumstances brought before you, any comparison of that nature appears to be not conclusive.

It does not appear that very much higher rates of speed would be required. There would be much more convenience from giving frequent departures, than from running particular trains at a very high velocity. And there is another question; after you have attained a speed of 40 or 45 miles an hour, the saving of time by the increase of speed does not go on *pro rata;* it is very much diminished. You save a great deal of time by an increase from 20 miles an hour to 40 miles an hour; but an increase from 40 to 50 miles an hour is not of that importance. With the present permanent way, where the rails are 70 to 75 lb. weight, you might travel certainly at 70 or 80 miles an hour.

The repairs are very much augmented by bad curves, and a wide carriage, or a wide engine, must be subject to a greater torsion from curves than a narrow one. Cannot believe that it is possible that the repairs of the wide gauge carriage and engines can be so little as of the narrow. Has no experience of the repairs on the wide gauge, but on a bad curve line the repairs are very much augmented. On the Newcastle and Carlisle, the repairs of the engines, as compared with the North Shields, are about £250 per engine per annum.

Has a return of the performance of a goods engine in ordinary working on the Midland line between Derby and Rugby; and whether you take it as the actual weight moved or the evaporating power, it stands a favorable comparison with any engine referred to in the evidence of Mr. Gooch. In one trip the engine took from Rugby a gross load of 348 tons 16 cwt., to which you would have to add her own weight and that of her tender, about 35 or 36 tons. She took that load up 16 feet a-mile from Rugby, and she acquired a velocity for that 16 feet a-mile, of 15 miles per hour. If you compare that with a level line, it is equivalent to a gross load of very nearly 700 tons on a level. The quantity of water evaporated on that length was 35½ gallons per mile; that is equal to about 100 feet per hour. Now,

from the experiments it appears, and it is consistent with one's notions, that the power of evaporation is directly, or nearly so, as the power of blast, that is, the number of strokes per minute, and the volume of that blast. From a return of an experiment on the Northern and Eastern, an engine which, at 30 miles an hour, evaporated not more than 70 or 80 feet per hour, evaporated 150 feet at 50 miles per hour.

[Mr. Bidder here assumes that the resistance to a train of 348 tons, on a gradient of 16 feet a-mile, is the same as that to a train of 700 tons on a level. The conclusion is independent of the velocity, and seems derived from taking the resistance of friction at 7 or 8 lb. per ton. This calculation omits the pressure on the blast pipe, which is a function of the velocity, and the resistance of the air, which is nearly as the square of the velocity, and depends, moreover, *not on the weight* of the train, but on the *surface* exposed to the action of the air. But setting all this aside, the amount of 7 or 8 lb. for friction is not even approximately correct, for it is certain that resistance from the unevenness of the rails, &c., is much greater at high than low velocities. The idea that "the power of evaporation is directly or nearly as the power of the blast," is contradicted hereafter by Mr. Bidder's own figures. Besides, if this theory were true, no water at all would be evaporated when the engine was standing still, for then the blast is not in action.]

On the last experiment the train was reduced to 72 tons 12 cwt. gross, a little more than half the first load. The net speed realized was 43 miles per hour, and the quantity of water evaporated was at about the rate of 190 feet per hour. This engine was a long-tube engine; the tubes are 13 feet long, 15 inch cylinders, 22 inch stroke, 5 feet 6 inch wheels; the area of the fire-box is 49·786 feet, and the heating surface of the tubes 738 feet. Then the letter from which I take this goes on,—"To prove the temperature of the heat in the smoke box I suspended four pieces of metal, viz., one piece three parts tin and two parts lead, one piece one part tin and four parts lead, one piece lead, and one piece zinc, their melting points respectively being 334°, 470°, 590°, and 680°. These metals being suspended immediately above the top row of the tubes, about one inch from the tube plate. I found at the end of the journey that the three first-mentioned metals had melted, but the zinc did not melt in any of the three trips, proving the temperature of the heated air to be about 600°." Now that shows that the temperature of the steam in the boiler being about 312°, and the air, when escaping from the tubes, being about 600°, it is quite clear that every part of those tubes must have been available in heating the water, and in the evaporation of steam; and by a comparison, taking the different loads and comparing them with the experiments of the goods engines, which are of a similar construction, with the same area of fire-box, and the same tube surface, you will find, as nearly as can be, that the evaporating power is a function of velocity, and also the function of the area of the cylinder. This clearly shows that the long boiler not only increases the evaporating power, but increases the economy in the conversion of water into steam.

[" This clearly shows" nothing of the kind. To get at anything like a trustworthy conclusion, the same experiment should have been made with a short-boiler engine, and the results compared. We are not told who made the experiments, or how they were made, and consequently do not know how far they deserve to be trusted. Our confidence, by the by, is not increased by reading that the fact the zinc did not melt proves " the temperature of the heated air to be about 600° :" this makes well for Mr. Bidder's side of the question, but all that can be legitimately concluded is, simply, that the temperature was under 680°—it may have been 670°. The fact that the temperature of the air was about double that of the steam, shows that not nearly all the heat of the former was usefully applied. To economise the whole of it, the hot air must continue to act on the steam till it can impart no more heat to it—that is, till the temperature of both is the same. How can we tell, *a priori*, that, if the experiment had been tried on a short engine, this result would not have been more nearly attained than with the long boiler engine, especially if we are to conclude that " the evaporating power is a function of velocity and also the function of the area of the cylinder," and does not depend on the amount of heating surface? It is to be observed the words, " is a function of," are incorrectly used as synonymous with " is *proportional* to."]

" In these experiments are you well assured that there was no priming ?—Yes, especially in the goods engine ; because, if you take that particular experiment to which I have alluded, where she took 385 tons gross up 16 feet a-mile ; if you take the area of the cylinders and see what quantity of steam must have passed through them in passing over that gradient, and see what was the volume of the steam at the requisite pressure to convey that train, you will find that the quantity of water is more than that which appears to have been consumed, which I attribute to the fact that they must have been using steam at rather a higher pressure than ordinary in the boiler.

" How did you ascertain the amount of evaporation ; after the experiment was over, how did you ascertain the quantity of water ?—They take the gauge of the tender, and the gauge in the boiler, and then they have the superficial area of the boiler at the different heights, and the area of the tender. It is ascertained with very great exactness, and great facility."

[Here Mr. Bidder assumes his proposition in order to prove it. He takes it for granted that there would be no priming, in order to show that there was none. First, with respect to the means of ascertaining the amount of evaporation : his method simply shows the quantity of water *got rid of*—not the amount converted into steam and usefully employed. The water *might* have passed away by leakage or priming,* or the steam might have escaped by the safety valve. But he is assured these contingencies could not have occurred, for he calculated the amount of work done, and the quantity of steam re-

* De Pambour shows that of the whole quantity of water consumed, one-fourth is, on the average, wasted by being drawn into the cylinders in a liquid state. So much for there being no priming!

quired to do it. He is certainly the first person who has been able to ascertain the resistance to a train with anything like the accuracy necessary for a calculation of this sort, and has increased the simplicity, if not the accuracy, of his operations by taking it for granted that 348 tons on a certain gradient are equivalent to 700 on a level. To find the quantity of water required to do the work, the recipe is to "take the area of the cylinders and see what quantity of steam passed through them," but who but Mr. Bidder could tell *a priori* how much that steam was dilated in coming from the boiler, and what was its precise effect while acting expansively—in other words, the exact nature of its mechanical action? Both problems are, considered separately, so intricate as to baffle all human ingenuity. The first, the resistance offered to the train depends on the wind, concussion at the joints of the rails, friction of the axles of the carriages, and other complicate mechanical actions, varying with every variation of velocity. The second, the mechanical effect of the steam, it is equally impossible to predict. The relation of the power of the steam to the quantity of water used, depends on the temperature and tension in the boiler, and the temperature and tension in the cylinder; the latter varying not only at every stroke, but (when the steam is used expansively) at almost every part of the stroke. It is therefore quite impossible to take the two problems separately; they must be considered together, as De Pambour has considered them. We have quite sufficient proof, however, that Mr. Bidder's calculations were all wrong, from his anomalous conclusion that *more* water was required than was actually expended! In accounting for this anomaly, he lets us into a secret;—he confesses that he did not know the pressure in the boiler, which of course should have been an essential ingredient in his calculation.]

A law seems to exist that the power of producing steam is as the velocity, that is, the number of blasts and the volumes in the cylinder; that is, as long as the fire-place will supply you with combustion to that amount; but as you increase the blast the combustion goes on in that ratio; and even with the Great Western experiments, and those taken with a short boiler, it is found almost invariably as the result, that 1 lb. of coke evaporates 7 lb. of water. With the long boiler we hardly ever get an effect of less than 8 lb. of water to 1 lb. of coke, and in some of these experiments it is as much as 10 lb. And we get economy in another way. In a comparison between engine power and the consumption of coke, you may get a fallacy from not knowing to what extent there may be pilotage in one line or another. If an engine on one line has double the amount of engine piloting which there is on another, her consumption goes into the general mileage; whereas the consumption of coke while running may be very much less. On the Northern and Eastern, when that line was first opened to Broxbourne, their engines only consumed 20 lb. of coke while running, and yet the daily returns showed 36 lb.; that was from the quantity burnt at the stations. Now a long-boiler engine is economical in that respect, because, no doubt, from the length of tubes, the quantity evaporated while standing and the coke con-

sumed is very much less; in fact, an engine with 13 feet tubes burns only half the coke standing that is consumed by an engine with 8 feet 6 tubes.

[In the first part of this paragraph the blast is supposed to increase the evaporation, but to also increase the consumption of coke *in the same ratio;* so that, though more coke is burned in an hour, the effect of each pound of coke is not increased. In other words, the blast is supposed not to increase the *economy* in the use of the coke. Now, it has always hitherto been supposed that a strong current of air (and, therefore, of oxygen) rendered the combustion not only more rapid but more *perfect* also, and that, where the supply of oxygen was insufficient, a great part of the fuel was wasted and passed away unconsumed, or without developing its evaporative power. It is, therefore, concluded that the rapidity of the current of air (within certain limits, of course,) increases the actual economy in the consumption of fuel. In the last sentence in the paragraph, "the quantity evaporated while standing" by a long boiler engine is supposed to be less than by a short boiler engine; and yet the principal argument in favor of the long boilers has always been understood to be their increased amount of heating surface, which might be supposed to increase the quantity of water evaporated, whether the engine were standing or in motion.]

"Do you think any good would result from the use of corrugated metal for fire-boxes?—I do not think there would be any. They get apparently a larger surface; but I think the effect upon that surface must be weakened to the same extent as you happen to extend the gauge. With a certain amount of combustible matter in a pound of coke, if you get the whole of that out, which we do with a long-tube engine more effectually than they do with a shorter one, from the fact that we get 8 lb. of water evaporated instead of 7 lb., I do not see myself how you can do more than extract that matter and apply it usefully; it does not matter whether it is in the fire-box or in the tube."

[Mr. Bidder does not see any use in increasing the surface of the fire-box, because "you can do no more than extract the matter and apply it usefully." But, then, that is assuming that *all* the matter is applied usefully in the long-boiler engines; whereas, he himself has proved that this is not the case, from the fact that the temperature in the tubes is twice that of the steam.]

There is a great difference of opinion respecting the atmospheric resistance; the fact has come before me from the experiments not only with the locomotive engines but on the atmospheric railway, where I see the power that has been expended and the result, and I cannot account for the expenditure but by atmospheric resistance, or some resistance which is a function of the velocity. For instance, I take a locomotive engine, No. 6, on the Northern and Eastern. I put behind that engine a train of 100 tons, she will travel with that train at the pace of 30 miles an hour and she will evaporate at the rate of 80 feet per hour. I reduce those 100 tons to 20, that engine goes at 50 miles an hour and evaporates at the rate of 150 feet per hour;

and I find, as nearly as can be, that the same quantity of water is converted into steam per mile with the light train as with the heavy train, showing that the *pressure upon the piston is nearly the same*, and that the power has been absorbed by this great augmentation of resistance.

[The blunder marked by italics rivals the celebrated notion started in the investigation of the Norfolk railway accident that an engine can be forced off the rails by the suddenly shutting off the steam. In the present case, Mr. Bidder evidently disregards the fact that the quantity of water drawn into the cylinder in a liquid state is much greater at high than at low velocities. Otherwise, how could he conclude that, because the same quantity of water was consumed during a slow as during a fast journey, the cylinder-pressure was the same in both cases? It is impossible to estimate the effective vaporisation by the water consumed; for even the mere circumstance of the boiler being fuller at one time than another will account for an enormous increase of priming. The inconsistency of this paragraph, with that in which Mr. Bidder states that he is "well assured there was no priming" is also to be noted. *There* he was able to calculate the resistance to the train with the utmost exactness; all language of uncertainty was avoided,—we were told to "*see*" the resistance of a train passing over a certain gradient, as if this *seeing* were the easiest process in the world. *Here*, however, the resistance is treated in quite a different mannner—it is some very vague uncertain thing, which Mr. Bidder "cannot account for" but by supposing there is "some" force or another (he knows not what) functional of the velocity. *Here*, too, the resistance can only be ascertained from the vaporisation. *There*, it could be calculated independently of the vaporisation—aye, and with that precision that the amount of priming could be deduced from the calculation. It is important to observe that, at ordinary boiler pressures, steam occupies *from four to five hundred times* the space of the water from which it is produced. This shows how enormously the evaporation is exaggerated by neglecting the effect of priming.]

The following are extracts from Mr. Bidder's report on the results of the experiments tried with the broad and narrow gauge engines:—

"Before calling your attention to the facts shown in these experiments, which cannot be influenced by any circumstances, and which, in my opinion, are alone worthy of your notice, I repeat that the object proposed was to ascertain the truth (and that alone) of statements which had respectively been made by Mr. Gooch and myself, as to the comparative power and economy of engines now in operation on the broad and narrow gauge lines, and more especially with respect to the importance of surface obtained by increasing the fire-box, or lengthening the tubes, and that any inference drawn from the results which shall bear on the merits of the two gauges will be foreign to the objects proposed, and false, as the circumstances of the experiments are not found to obtain in practice. Supposing, however, that they were, and that an increase of power were deemed desirable, I do not hesitate to say that that which is at present found ample

for all purposes might be doubled, or more than doubled, on either gauge.* I shall now proceed to examine the evaporating power of the engines, as well as the relative economy of evaporation and efficient application of the steam evaporated. It will be recollected that on the part of the broad gauge, it was alleged (in reference to the statement that on the narrow gauge, not only economy but power was obtained by lengthening the boiler) that the area of the fire-box alone was the test of the power of the locomotive engine, and that two cubic feet of water per hour per superficial foot of fire-box gave the capacity of evaporation of locomotive engines; and thus it was alleged, that the Great Western engines could evaporate nearly 200 cubic feet per hour, while the narrow gauge engines could only convert into steam 100 cubic feet, the comparative fire-box surfaces being as 97 feet to 50 feet. In order at once to test this principle, let us examine the facts shown in the experiments. By reference to the particulars of the experiment with 50 tons with engine A, on December 31st, 1845, between Darlington and York, a distance of 88½ miles, it will be found that the water evaporated is 20,520 lb., being at the rate of 232 lb. per mile. In the (up) journey the first mile, as well as the last 1¼, were passed over slowly; as also were the first quarter and last mile on the return trip, in all 3½ miles. In order, therefore, to get at the maximum average rate of evaporation on the trial, I take 20,250 lb., less 812 lb. (the water consumed in passing over the above 3½ miles, at the rate of 232 lb. per mile), 19,700 lb., the weight of water evaporated by the engine in passing over the remaining 85 miles, which was effected in 106 minutes 12 seconds, being at the rate of 11,150 lb., 178 cubic feet per hour. I will now compare this with the experiment most resembling it in regard to the evaporation tried on the broad gauge. I take the experiment with 60 tons on December 17th. The total water evaporated was 24,640 lb., on 106 miles, or 232 lb. per mile: deducting from this 1,044 lb. for water due to 4½ miles passed over slowly, leaves 22,596 lb. of water evaporated in 112 minutes and 42 seconds, being at the rate of 11,820 lb., 189 cubic feet per hour, that is little more than the evaporation of the narrow gauge engine. When, however, we compare the coke, we find, in the case of the broad gauge engine, that 7·8 lb. of water only were converted into steam by 1 lb. of coke, whilst the narrow gauge engine evaporated 9·6 lb., being a difference in regard to economy of fuel of 23 per cent. in favor of the narrow gauge engine."

* "In evidence given by Mr. Gooch, the average gross weight of passenger trains on some of the principal railways is given as follows:

| —— | Great Western Railway. | Grand Junction Railway. | London and Birmingham Railway. | Birmingham and Gloster Railway. | South Western Railway. |
|---|---|---|---|---|---|
| Average gross weight in tons. | 67 | 43 | 42 | 38 | 36 |

The lightest of the trains included in the above average are express trains; there are now, therefore, engines in use on both gauges capable of taking trains of double the weight of those required in practice of the express speeds."

From the concluding sentence of this quotation, it is clear that Mr. Bidder's only test of the relative economy of the two engines is—not which does the greatest quantity of work for a given quantity of coke—but, which gets rid of the greatest quantity of water for a given quantity of coke: and, accordingly, he has drawn up a tabular account of the experiments, wherein, in the very cases in which the broad gauge engine evidently did the most work with a pound of coke, he concludes that because it did its work with a small quantity of water, *therefore* the engine was comparatively uneconomic! If the table were not actually printed and published, our readers might perhaps doubt whether we had fairly represented its contents. The following, however, is an exact copy:—

| Experiments. | | Engine. | Water evaporated per mile. | Coke consumed per mile. | Water Evaporated per lb. of coke. | — |
|---|---|---|---|---|---|---|
| No. | Tons. | | lbs. | lbs. | lbs. | |
| 1 | 80 | Ixion, | 245 | 33·6 | 7·12 | Broad gauge. |
| 2 | 70 | Ixion, | 233¾ | 33·6 | 7·12 | |
| 3 | 60 | Ixion, | 232 | 29·6 | 7· 8 | |
| 1 | 50 | 30th Dec., A. | 291 | 31·2 | 9·3 | Narrow gauge |
| 2 | 50 | 31st Dec., A. | 232 | 24· | 9·6 | |
| 3 | 80 | 31st Dec., A. | 235·7 | 26·6 | 8·8 | |

The fifth column gives, according to Mr. Bidder's views, the figures by which the economy of the engines is to be tested. Let us take the first experiment in each case. In the narrow gauge experiment, No. 1, the train was 50 tons, and the consumption of coke 31·2 lb. per mile: in the broad gauge experiment the train was 80 tons, and the consumption of coke *not* 2½ lb. *more per mile*. It is obvious that the 2½ lb. will not alone account for the enormous difference between the two loads—namely 30 tons. The only conclusion which any rational unprejudiced man could draw would be that more work was got out of the coke in the one case than in the other. And this conclusion would be greatly confirmed by observing what Mr. Bidder omits mentioning, that the broad gauge train moved *fourteen miles an hour faster* than the narrow gauge train. And yet, because the water evaporated was less in one case than the other, we are provided with a fifth column of "water evaporated per lb. of coke," from which it is gravely inferred that the narrow gauge trip was performed the most economically! We must protest against this wholesale method of jumping at conclusions which shows a lamentable confusion of ideas respecting the mechanical action of steam.

We said that Mr. Bidder's own figures contradicted his hypothesis that "the quantum of evaporation is a function of [*i. e.* is proportional to] the number of blasts per minute." Taking Nos. 1 and 3 of the broad gauge trips, which were respectively the slowest and fastest trips, the quantity of water in the first case was the *greatest* (viz., 245 lb.) and in the second the *least* (viz., 232 lb.). We get precisely the same result with the fastest and slowest of the narrow gauge journeys: so that if Mr. Bidder's table prove any relation of the evapo-

ration to the blast at all, the conclusion must be the very reverse of his theory. It has been ascertained that, if an engine be deprived of its blast pipe, the rate of evaporation will be reduced to about one-fifth; but from the few experiments instituted under this head, it would appear that under ordinary circumstances, when the blast is in action, its effect on the rate of evaporation varies as the fourth root of the velocity.

Before concluding these observations, we ought to offer some remarks on the particular circumstances under which the narrow gauge experiments were made. The following extracts from Mr. Gooch's report are not a little surprising "*The engine was on each occasion placed at Darlington over a powerful stationary blast for the purpose of getting very hot water in the tender and a bright fire to start with.*" By these means, the water in the tender was raised to 180°. In the experiments with goods trains, "*the engine was placed over the blast, and remained there an hour and a half. The tender containing warm water was taken from another engine and attached to the regular tender, and men were provided to bucket the water from one tender to another as the train was moving.*" Mr. Gooch plaintively observes that this contrivance would have been of great use in the broad gauge experiments.

The love of philosophical accuracy displayed by the conductors of the narrow gauge experiments precludes the supposition that *they* sanctioned these devices, which must therefore be attributed to the subordinate officers of the railway. But, at all events, they sufficiently account for the circumstance that the narrow gauge engines got rid of more water for each pound of coke (although they generally did less work for each pound of coke) than the broad gauge engines. It is, of course, more easy in the dead of winter to boil water previously raised to a temperature of 180° than water originally at the temperature of the atmosphere.

We must guard ourselves against the supposition that the experiments prove decisively the superiority of the broad gauge engines. In fact, they prove *nothing*. They were so few and so improperly conducted that no trustworthy conclusion can be derived from them. They ought to have been repeated several times over, under the superintendence of disinterested persons, whose object was—not to get up a series of showy results—but to exhibit as nearly as possible, the *ordinary* working of either kind of engines. However, the observations here made will have, at least, one good effect: they will enable the reader to appreciate the philosophy given in evidence before public commissions on engineering questions, and to estimate the value of the experiments authoritatively sanctioned.

Civ. Eng. & Arch. Journal.

---

*Extracts from "Observations on the Western Trade," in reference to the proposed Hudson River Railroad. By* Wm. H. Grant, Civil Engineer.

I have obtained from Legislative documents, the yearly statements of the "*Assessed value of Real and Personal Estate in the city of*

*New York,*" from 1815 to 1845, inclusive, and arranged them in the following table.

*Chronological Table of the Assessed value of Real and Personal Estate in the City of New York, from* 1815 *to* 1845, *inclusive.*

| | | |
|---|---|---|
| 1815 | $81,636,042 | Close of the last war with Great Britain. |
| 1816 | 82,074,200 | |
| 1817 | 78,895,735 | |
| 1818 | 80,245,091 | |
| 1819 | 79,113,061 | |
| 1820 | 69,539,753 | |
| 1821 | 68,285,070 | |
| 1822 | 71,289,144 | |
| 1823 | 70,940,820 | |
| 1824 | 83,075,676 | |
| 1825 | 101,160,046 | Completion of the Erie Canal. |
| 1826 | 107,477,781 | |
| 1827 | 112,211,926 | |
| 1828 | 114,019,533 | |
| 1829 | 112,526,016 | |
| 1830 | 125,288,518 | |
| 1831 | 139,280,214 | Completion of the Ohio Canal, from Cleveland on Lake Erie to Portsmouth on the Ohio river; distance 307 miles. |
| 1832 | 146,302,618 | |
| 1833 | 166,495,187 | |
| 1834 | 186,548,511 | |
| 1835 | 218,723,703 | |
| 1836 | 309,500,920 | |
| 1837 | 263,747,350 | |
| 1838 | 264,152,941 | |
| 1839 | 266,882,430 | |
| 1840 | 252,135,515 | Completion of the Western Railroad, in connexion with the Boston and Worcester, and the Albany and West Stockbridge Railroads, extending from Boston to Albany; 200 miles. |
| 1841 | 252,194,920 | |
| 1842 | 237,806,901 | |
| 1843 | 229,229,077 | |
| 1844 | 236,727,143 | |
| 1845 | 239,995,517 | |

Running the eye over this table, it will show, at the first glance, its striking aptitude as an index to the growth and prosperity of the city of New York.

The three principal eras are strongly marked.

I have already alluded to the stationary position she held from the close of the war to the completion of the Erie canal, in 1825, while Pennsylvania was monopolizing the western trade, which is so strongly exemplified by this table; and also, to her sudden start in wealth and rapid increase from that time onward to 1840, about the period of opening the Western railroad.

In 1832, it will be seen, an additional impulse was given to the trade by the Ohio canal, opening an important avenue to Lake Erie. From 1825 to 1840 and '41, it shows, in an unerring and demonstrative manner, the constant and unchecked increase of the wealth of New York.

In 1841, the assessed value of real and personal estate in the city was $252,194,920,—it had ranged higher in 1836 and the three years following, during the inflated period, when every species of property

obtained a fictitious value,—but it is $33,000,000 higher than in 1835, and shows an annual increase of 8 per cent. for the last preceding ten years, and of 9½ per cent. for each year from 1825. It may be regarded as a fair and substantial valuation for that time. And what follows from this period? It stops here as firmly as if the city had been visited by some fearful calamity.

This may appear somewhat incredible; but cast the eye back again upon the column of figures, and trace it down; there is no longer the steady increase; there is an actual diminution; follow it down to 1845, and there is a falling off since 1841 of $12,000,000! There is nothing fallacious about it. There are the figures.

The ascending ratio no longer holds good, but it is actually inverted; instead of increasing at the rate of 9½ per cent., or 8 per cent. per annum, *the value of real estate has declined at the rate of nearly* 1½ *per cent. per annum from* 1841 *to the present time!*

New York, for the first time in sixteen years, has received a check in her career. Worse: for the first time in her whole history she has retrograded.

Her positive loss has been $12,000,000, which has been absolutely abstracted from her wealth. Let us continue the ratio of increase for the ten years preceding 1841, of 8 per cent. per annum, the lowest possible ratio that could be applied, and see what her valuation *should* have been in 1845. An annual increase of 8 per cent. on the sum of $252,194,920, the valuation in 1841, makes $332,818,880. The difference between these two sums is, in round numbers, *eighty-one millions of dollars, which is the loss she has practically sustained in the last four years; an amount greater than her whole wealth two years previous to the completion of the Erie canal, and equal to one-half of the entire wealth she has accumulated since it has been in operation.*

These are facts that every man can investigate for himself. They may appear incredible, and doubtless would be held so, were not the evidence, "clear as proof of holy writ," at hand. They are stubborn and startling *facts*, that must be looked full in the face; they cannot be evaded.

I could mention a number of instances in which they have been stated to men of intelligence and high business qualifications, who have received them with the most positive unbelief and incredulity; and I believe it is not presumptuous to say that half of the active capital held in the city of New York, is held by persons unconscious,—if not of their real existence, of their extent and consequences.

What! is it to be believed that New York, with her great resources, her enterprising population and fertile soil, her unrivalled natural advantages, is for a moment to pause in her proud career? New York, with her magnificent bay and harbor, her boasted Hudson, and her "grand Canal," with the connected system of internal improvements embracing 700 miles of artificial navigation,—to retrograde in her giant progress, and to sink annually for four years $3,000,000, instead of accumulating 10½ millions, which is but the average rate of increase for 16 years previous to 1841? No; it is idle to talk of it; it is absurd, and contrary to all experience and all habits of thinking and

observation. Mathematical demonstration will scarcely prove rigorous enough to establish it on the minds of half a million of people, whose every interest, great or small, is opposed to it.

Our "Grand Canal," truly! why it has been made subservient, with our whole canal system, and our line of railroads from Albany to Buffalo, to the city of Boston; our internal resources, industry, and capital, and even our merchants, mechanics, and farmers, have become tributary to her.

Look about the land,—in our populous towns, villages, and hamlets along the thoroughfares to the west, to the north, and into the interior,—and see if you do not find the enterprizing New Englander established there, fresh from Boston, with his wares and manufactures, and merchandize, and "notions" of all descriptions, and competing successfully with our citizens. Look at the manufacturing establishments springing up from Massachusetts capital, and even railroads projected and carried into operation by it on our own soil, all tending to the same end—to build up Boston at the expense of New York. Look at the trains of the Western railroad as they depart from the depot at East Albany, and see if they are not loaded down and groaning under the burden of our own products and the products of the west, carrying our merchants and the merchants from distant States, that formerly thronged to New York, rapidly and en masse to the city of Boston. See them return with similar burdens, and sending them far and near, scattering them broadcast throughout the country, to the exclusion of the legitimate trade of New York. And this too, while the channels of competition are all open, and the Hudson river is offering its superior navigation of 150 miles against 200 miles of railroad, over mountains and on unparalleled grades.

But more than all; see this *only* avenue to New York closed and hermetically sealed nearly one-third of the year, and the whole trade of the interior and the west, without stint or diminution, concentrating upon the city of Boston.

After this, say if the evidence these things furnish does not confirm and strengthen the humiliating fact, that New York has been shorn of her strength, has fallen from her high position, and in proportion as she has declined Boston has triumphantly risen.

But let us turn our attention to Boston and ascertain how the case actually stands with her. In 1841 the value of her real and personal estate was but $98,000,000; it increased by regular gradation from that year to 1845 to $135,000,000, making an advance, in the four years, of $37,000,000. This is equal to 9¼ per cent. annual increase, and equal to the highest rate New York has ever attained. If we take the rate of 8 per cent. at which New York advanced previous to 1841, and the rate at which she should have continued to advance, and add to it the rate of 1¼ per cent. which shows her decline since, *it corresponds, within a fraction, with the actual per centage gain of Boston.* Her progress has been truly astonishing, considering her past history and comparatively slow and toilsome advance through a long series of years. It surpasses that of Philadelphia in her palmiest days, when the entire western trade was poured into her lap.

To show the influence the Western railroad has had in producing these results, let us look at the business it is doing. The bare receipts of the road for transportation were, in

| | | | |
|---|---|---|---|
| 1842, | $ 512,688 | 1843, | $ 573,882 |
| 1844, | 753,752 | 1845, | 813,480 |

For the last year they were $813,480, a sum that would in itself enable a sagacious person to form a tolerably correct estimate of the value of the immense business to Boston, from which it is derived from transportation alone.

The number of tons of merchandize carried over the road from 1842 to 1845, averaged yearly 66,000, and was, in 1845, 93,392 tons. To assign a value to this amount of merchandize, approaching accuracy, is perhaps no easy matter, but still it may be approximated very closely.

The "total movement" on all the State canals during the last season, of articles similar to those transported over this road, included under the several heads of "Agriculture," "Manufactures," and "Merchandize," (excluding "products of the forest,") was 867,000 tons, the value of which, as officially ascertained and reported to the Legislature, was $89,000,000. From this proportion the value of the 93,392 tons carried over this road is found to be *nine and a half millions*, which is, with great probability, very near the mark.

The "total movement" on the canals is made up of the amounts ascertained to have moved between the several collectors' offices, and for a greater distance; a large portion moving but a few miles, 5, 10, 20, 100, or 200 miles, as the case may be, and the remainder over the whole line; that is, over the Erie canal, or over one of the lateral canals and a part of the Erie canal. The amount that corresponds the most nearly with this total movement, in the statistics of the Western road, is the "number of tons carried one mile." This, for the year 1845, was 14,569,223 tons. The number of passengers carried over the road was 223,600.

The value of the trade, as before stated, of $9,500,000, is exclusive of the benefits derived from this number of passengers carried annually to and from the city of Boston, forming business connexions, and extending and strengthening her commercial intercourse with the merchants, and producing, and consuming classes of the west.

That Boston duly appreciates these results, and attributes them to the true source,—whatever may be the opinion of New York, or her indifference to the fact—no one can doubt, who gives her credit for ordinary intelligence. She has already contemplated and taken measures to construct a double track to the Western railroad, an improvement demanded by the rapidly increasing business upon it.

All her energies are directed and centered upon the vantage ground she has gained, with a fixed resolution to make the most of the position her superior enterprize alone has given her. She has wisely estimated the value of an uninterrupted access at all seasons of the year with the west, which the progress of trade and the spirit of the age have alike rendered indispensable, and her citizens are fully sensible

of the triumph they have gained over the ice-bound Hudson. Daily experience and the most familiar and ordinary business transactions afford them practical illustrations of its importance.

What would they say of the merchant, who, with an active competition around him, keeps his store open but six hours in the day, while others keep their's open nine? What would they say of the mechanic who labors in his shop but two hours to his fellow's three, and lounges away in idleness one-third of his valuable time? Or, what would they say of the capitalist who invests his funds but two-thirds of the year, and hoards them up during the remainder, without receiving a dividend or a return in any manner? They would say, that in one case, the man was wilfully blind and negligent of his best interests, and in the end would be reduced to poverty; and in the other, that industry and prompt attention to advantages open to all, would be sure to secure its deserved reward. Whether New York is passive and indifferent to these facts, or tardily realizes them and endeavors to practise the lessons they teach, Boston will keep on, profiting by her experience, and will retain in her grasp the advantages she has gained with a tenacity that will only yield in the greatest emergency.

Now it may be said, in answer to all this argument about the advance of Boston and the decline of New York,—"True, New York has lost in four years $12,000,000, or you may call it $81,000,000, if you choose, and Boston has gained $37,000,000, but it is merely a temporary fluctuation that the times are subject to; New York will soon regain her position, and outstrip Boston with ease; and, besides, small losses do not affect her, her energies are recuperative, and she emerges from every disaster only to take a higher and prouder flight than her previous one." But is not this a palpable fallacy in view of the actual facts?

New York *has* overcome and outlived great misfortunes; she has nobly risen from her ashes on one occasion and exhibited a renewed vigor and a brighter aspect after it, and she is now emerging (less rapidly) from a similar but less serious calamity. The conflagration of 1835 was a visitation such as few cities could survive, much less efface and repair in ten years; but how was New York situated to meet the blow? She was in the midst of unrivalled prosperity, and all the elements of her undiminished greatness conspiring to alleviate its consequences and raise her from the momentary depression it caused. Her resources were not then distracted or diverted from her, and the chasm made in her wealth was soon filled, and all went on as before. But should such a disaster occur now, how would she be prepared to meet it? Has she ever been placed in a condition similar to the present one? Her trade is departing from her at the rate of $3,000,000 a year, and she has fallen back in 4 years $81,000,000, instead of her wealth being at this time enhanced, as it should be, by that amount. She has experienced no reverses like this, or ever found herself in a dilemma such as it involves, yet she is to extricate herself from it with ease and unconcern!

How is it to be done? Is there some latent spring of revivifying and recreative power within her corporate limits that is to sustain and

prop her up in defiance of all extraneous influences? Is Boston to relax her efforts; or upon what tangible evidence does she rest for the great good fortune she anticipates? There may be some resources upon which she relies, not palpable to an unimaginative eye, but to plain practical common sense there is no other than the construction of the Hudson River railroad. If she will look to this, she will see the *means*, and if she will look to the west she will see the *substance* of her relief. The western trade, which has trebled her wealth and has been the real source of her vitality so long as the Erie canal was tributary to her, has been "tapped" by Boston, and the only way it can be recovered is to complete this railroad without delay, and open anew to her the great and commanding advantages she has temporarily resigned.

---

## AMERICAN PATENTS.

*List of American Patents which issued in the month of February, 1846,—with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an *Improvement in the Straw Cutter;* Samuel G. Blackman, Norwalk, Connecticut, February 10.

The patentee says:—"My improvement is applicable only to that class of straw cutters which cut by means of knives attached to and radiating from the centre of a shaft or roller, and acting against the surface of a cylinder of wood, lead, or other substance. The object of my invention is to prevent cutting into this cylinder, and I effect it by suspending the boxes in which the journals of the cylinder work between helical springs, placed above and below, with temper screws that bear on the top of the upper springs, so that the surface of the cylinder can be regulated at pleasure to make the requisite pressure on the edges of the knives as they pass, and yet not sink so much between them as to injure the surface of the cylinder, and waste the power."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is suspending the boxes on which the journals of the cylinder run between two sets of springs placed above and below, the upper set being regulated by temper screws or other analogous device, in combination with the roller of radial knives that cut against the surface of the cylinder as herein described."

---

2. For *Improvements in Machinery for making Glazed Cotton Wadding;* Jeremiah Essex, Bennington, Vermont, February 10.

The first part of this invention consists "in ranging a series of carding engines, one behind another over an apron which has a continuous movement, so that the sliver or sheet of cotton from the second card is delivered on top of that from the first, the one from the

third on to that of the second, and so on to the end of the series, the number of carding engines being in proportion to the quality and thickness of the bat or wadding desired: it being a fact well known to those versed in the art of working fibrous materials, that the thinner each sliver the more perfect will be the bat, and it will be evident that with my method this can be refined to any desired extent.

"The second part of this invention consists in passing the glazed bat or wadding from the glazing apparatus through the kiln or hot air chamber over a series of open reels arranged side by side on one plane, and extending from end to end of the kiln, one reel delivering the bat on to another, and so on to the last of the series where it is delivered out. If the bat is glazed on both sides before it is introduced into the kiln, but one set of reels is used; but I prefer to glaze it first on one side, dry this by passing it through the kiln on one set of reels, and deliver it at the other end to the second glazing apparatus to be glazed on the other side and then passed through the kiln on another set of reels above the first. In this way I avoid the inconvenience of accumulating the glazing or sizing on the rods of the reels, for in passing through the first time the unglazed surface rests on the bars of the reel, and the second time, the side first glazed. In this way I avoid what would otherwise be a serious inconvenience."

Claim.—"What I claim as my invention, and desire to secure by letters patent. is arranging a series of carding engines one behind another and over a single apron to form a bat of several thicknesses of slivers, as herein described. And I also claim the arrangement of one or more series of reels that rotate by means of cog-wheels or other equivalent, to convey the bat in combination with the glazing or sizing apparatus for glazing or sizing and drying cotton or other bat or wadding, substantially as herein described."

---

3. For an *Improvement in the Cooking Stove:* Joseph Laubach, Harrisburg, Pennsylvania, February 10.

This is for an improvement in a cooking stove having one small oven back of the fire place and a large one below, and the improvement patented consists in having a large circular hole (called a diving flue in the specification) in the middle of the flue that passes under the large bottom oven, for the purpose of carrying the draught down into a flue below that leads to the exit flue at the back, the said hole being surrounded by movable segment plates to open or close this hole. When closed the draught passes over the top of the large oven, down in front, under the bottom, and up the back; but when open, and the other dampers are properly regulated, the draught divides into two currents at the top of the oven, one portion passes down the front and the other down the back, both pass under the oven, dive down through this hole into another flue below—and thence up the back flue to the exit pipe.

We are under the necessity of omitting the claim as it depends on the drawings, but it is limited to the arrangement and combination above pointed out.

4. For an *Improvement in the Portable Horse Power for Driving Machinery, called the Locomotive Horse Power;* I. J. Richardson, New York City, February 10.

Claim.—"Having thus fully described the manner in which I construct, combine, and arrange the respective parts of my locomotive horse power for driving machinery, I do hereby declare that I do not make any claim to the manner of arranging the wheels and pinions which constitute the gearing, such gearing being of a kind well known to machinists: but what I do claim as new, and desire to secure by letters patent, is the placing of the master wheel beneath the main beams or body of the carriage in such manner as that it can remain permanently attached in its place as described, in combination with the placing of the residue of the machinery in a separate frame to turn over upon hinges, or a hinge or pivot as above set forth, thereby removing all impediment to the transportation, and admitting of the whole being readily replaced in gear by turning the independent frame back into its working position."

---

5. For an *Improvement in Stoves for Heating Apartments;* Charles W. Leet, Vernon, New York, February 10.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the manner of conveying the draught, as before described, that is to say, causing the draught to pass over the upper edge of the front half of the inner cylinder, thence down between the inner and outer cylinders, into the oval base, and thence up the columns into the oval cap, and thence down into the semi-circular space between the inner and outer cylinders, and thence to the smoke pipe as above set forth."

---

6. For an *Improvement in the Washing Machine;* John H. Aldrich and Otis C. Foote, Rushville, New York, February 10.

This invention consists in subjecting the clothes, in a tub or box, to the combined action of rubbing, squeezing, and pounding, by means of a rubber, or pounder, connected with a hand lever by means of two jointed links, so that as the lever is depressed, the pounder or rubber shall gradually approach a fluted wash-board at the bottom, rubbing and squeezing the clothes, and then strike against the back of the tub or box, to pound the clothes which have been pushed towards the back, either by the action of the rubber or by the hand of the attendant. One of the links being jointed to the back of the rubber or pounder, and the other to the top thereof, the latter being jointed to the handle about midway between the fulcrum of the hand lever and the joint of the other link, to insure the compound movement of the rubber or pounder.

Claim.—"What we claim as our invention and desire to secure by letters patent, is connecting the pounder or rubber of a washing machine with the hand lever, by means of the two jointed links, to give it the required downward and forward motions, whereby the clothes

in the box or tub are rubbed and squeezed, or compressed on the wash-board at the bottom, and pounded against the back, as herein described."

---

7. For an *Improvement in the Ovens of Cooking Stoves;* Geo. W. Eddy, Waterford, New York, February 10.

Claim.—"My improvement, and that which I claim, and for which I ask for letters patent, consists in combining a hollow oven door, or one with flues within it, with induction and eduction openings or passages in its turning bearings; the said openings being for the reception and discharge of smoke into and from the said doors, substantially in the manner and for the purpose as set forth."

---

8. For an *Improvement in the Straw Cutter;* Joseph W. Webb, Lockport, New York, February 10.

In a straw cutter secured to the patentee by letters patent bearing date the 2nd day of July, in the year 1842, in which the knives, straight on the cutting edge and face, are connected with the shaft or stock, with the cutting edges on a line diagonal therewith, and the outer face on tangents, so that that end which first commences the cut is tangential to a smaller diameter than the other, or in other words, in which the faces of the knives are tangential to a cone, for purposes fully expressed in the letters patent before recited, experience has shown the importance of having them so connected with the stock or shaft as to admit of adjustment as their cutting edges wear, for it is evident that as the cutting edge wears away, its diameter decreases, and will not act against the bed cutter at the end of the box, and therefore it becomes necessary to attach them to adjustable arms, which, by means of screw-bolts and elongated holes or slots, will admit of the adjustment of the edge of the knives to the edge of the bed cutter or shear; but as the wear from inequality in the texture of the metal, or unequal grinding, is irregular, it frequently occurs that one end must be moved out more than the other, which bends the knives, if secured to flat faces or seats on the ends of the arms to which they are attached, and varies their cutting line; and therefore, to avoid this defect, the ends of the arms, or the faces to which the knives are attached, are beveled on each side, so that they (the knives) rest on the ridges thus formed, and admit of easy adjustment, without the liability of bending.

Claim.—"What I claim as my invention and desire to secure by letters patent, is attaching the knives to the beveled faces of the flanch pieces, to admit of their readily taking any inclination without bending, in combination with the means of adjusting their cutting edge to the bed cutter or shear, by connecting the flanch pieces to which they are attached by screw-bolts passing through elongated holes or slots, substantially as herein described."

9. For an *Improvement in Weavers' Temples;* Arnold Palmer, New Lebanon, New York, February 10.

The object of this improvement and its general character are clearly indicated in the following claim:

Claim.—"What I claim as my invention and desire to secure by letters patent, is the mode of combining and arranging the parts composing my self-acting temple, so that the jaws commence closing upon the selvage while the latter is *advancing towards the filling*, and after firmly holding the cloth, at the moment of 'beating up,' open, and leave it at liberty to vibrate while the sheds are changing. The whole being constructed and operating as described and shown."

---

10. For *Improvements in the Cooking Stove;* Samuel Graves, Auburn, New York, February 10.

We are under the necessity of omitting the claims in this instance, on account of their reference to, and dependence, on the drawings. The first section is limited to the employment of flues in the ends of the oven, communicating with the space in double oven doors, by means of valves which close the connexion when the doors are open, in combination with an arrangement of dampers for directing the draught around any part of the stove. The second section is limited to the employment of air chambers in front of the valves or dampers, which direct the draught under the boilers, for the purpose of protecting them from the intense action of the fire. And the third section is limited to the employment of a damper, or hinged partition, in the flue under the boilers, and placed in the middle thereof, and longitudinally, for the purpose of confining the heat to one set of boilers only.

---

11. For a *Safety Car, for Ascending and Descending the Inclined Planes of Railroads;* John Tittle, Johnstown, Pennsylvania, February 10.

This is a car which is to be placed forward of the train in descending, and back of it in ascending. It consists of a frame, one end of which is connected with the axle of a pair of wheels by means of a spring, the sides of the frame being formed like brakes, to gripe the tread of the wheels when borne down by the weight of a descending car, which, when separated from the locomotive, or other machinery, runs on the sides of the frame that rest and run on the rails, and are wedge-formed for that purpose, and thus the frame is forced down on to the wheels, which chucks them.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the construction of the body of the safety car, as aforesaid, in combination with the supporting wheels, axle, and spring, arranged and operating in the manner and for the purpose set forth."

12. For an *Improvement in Dressing Mill Stones;* Elisha S. Snyder, Charlestown, Jefferson county, Virginia, February 10.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the before described mode of dressing millstones, that is to say in ridges and furrows tangential to the eye, each furrow gradually *increasing* in *width* and *depth*, from the eye to the circumference, being of a triangular shape in its vertical cross section, and every alternate ridge being omitted from the eye to the circle, forming large triangular cavities for the admission of the grain to be broken, preparatory to its passing to the long furrows, to be ground into flour."

---

13. For an *Improvement in the Condensing and Feeding Apparatus of Steam Engines;* Joseph P. Pierson, Jr., New York, February 10.

The patentee says,—"The nature of my invention consists in a refrigerating apparatus attached to the cylinder of the steam engine, wherein the water for condensation and the condensed steam are so distributed that a constant supply of fresh water is returned to the boilers, and also of cold water, for the condensation of its steam."

Claim.—"What I claim as my invention and desire to secure by letters patent, is the refrigerator, as herein described, in combination with any of the known jet condensers—the said refrigerator receiving that portion of the water from the condenser which is not immediately returned to the boiler, cooling the same sufficiently for use in condensing, and returning it to the jet for the condensation of the steam from the cylinder; the whole being combined and operating substantially as set forth."

---

14. For an *Improvement in the Straw Cutter;* I. J. Richardson, New York, February 10.

In this machine the straw is fed in through a vertical hopper, and rests on a board below, which receives a vibratory motion, up and down, from a cam on the crank shaft. The two knives are of a triangular form, the point of one corresponding with the cavity of the other, and these are attached to a horizontally sliding gate, to cut the ends of the straw resting on the feed-board, and projected below their plane of motion.

Claim.—"What I claim and wish to secure by letters patent, is the use of two triangular edged knives, combined in a straw-cutting machine, operated substantially in the manner above described.

"I also claim the manner of combining the feed-board, or gauge, with the straw cutter, substantially as above described."

---

15. For an *Improvement in the Machine for Sowing Grain;* Wm. J. Jones & H. C. Smith, Fairfield, Connecticut, February 20.

In this machine there is a horizontal roller running in the opening at the bottom of the hopper, which roller is provided with recesses or

cups to receive and measure the quantity of grain or manure to be carried out, and by its revolution the contents of these cups are delivered to the action of another roller parallel with it, and provided with pins, which scatters the seeds, &c.

Claim.—"We do not claim to have invented any of the parts above described, each taken separately being well known. But we do claim as new, and of our invention, and desire to secure by letters patent, the application of mortices and boxes, or cups, in the feeding roller, to measure off any proportionate quantity of seed or manure for deposite in any given surface of ground, in combination with the scattering roller, fitted with pins or beaters, when such application and combination is employed for the purposes herein set forth, and constructed and operating substantially as herein described and shown."

---

16. For *Improvements in the Filter;* Wm. H. Jennison, New York, February 20.

The objects of these improvements are to afford a more perfect and ready means of cleansing, and a more simple and effective filter, by constructing the case of the filter with two chambers, so arranged that it can be reversed and have either end attached to the pipe which delivers the water or other liquid to be filtered, and filtering through a conical bag of felted, or other cloth, so connected with the case that, when the apparatus or the direction of the water is reversed, it shall be turned inside out, the better to insure the delivery of the deposit.

Claim.—"What I claim as my invention and desire to secure by letters patent, is making the double case containing the filtering medium so that it can be reversed, substantially as herein described, to admit of the ready discharge of the impurities previously deposited, as herein described. And I also claim the employment, for the purposes of filtering, of a cone of felt, or other porous substance, to play within two chambers, substantially as herein described, so that by either reversing the whole apparatus, or the direction of the flow of the water, or other liquid, the cone shall be reversed, to admit of the more ready discharge of the impurities from its pores, as described."

---

17. For an *Improvement in the Mortising Machine;* Benjamin H. Otis, Dedham, Massachusetts, February 20.

On the sliding chisel rod there is a helical spring to raise the chisel, and this rod is connected with a collar at the top, that is attached to the connecting rod of the treadle or lever, and in this collar the rod can be turned, so as to present the face of the chisel in different directions.

Claim.—"What I claim as my invention and desire to have secured to me by letters patent, is the combination of the loose collar and fast collar, arranged at the top of the chisel rod, and having notches and studs, or teeth, respectively, as described, *with the spiral spring on which the said chisel rod is supported*, so that the *same* spiral spring which retracts the chisel, (by the combination above stated,) allows

or provides for the turning round of the chisel ninety degrees, for the purpose and in the manner set forth."

---

18. For an *Improvement in the Safety Valve;* John Shorb, Canton, Ohio, February 20.

The object of this improvement is to prevent the adhesion of the main valve, by means of another valve, the lifting of which elevates a lever connected with the main valve.

We are under the necessity of omitting the claim, as it refers to, and is wholly dependent on, the drawings.

---

19. For an *Improved Method of Making Candles;* John Drummond, New York, February 20.

The nature of this invention consists in forming candles of tallow, (or other concrete fats) by forcing it, in the liquid or solid state, through a tube, and around the wicking, which is introduced through a small tube having its delivery end concentric with, and the upper end carried through, the side of the outer or forming tube, thus causing it (the tallow) to unite to the wicking and to be discharged from the lower end of the moulding tube, in a cylindrical form and in a solid state, so that it can be cut into the required lengths for candles.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method of making candles by forcing the tallow or other suitable material, through a moulding tube, when this is combined with a small tube within it, through which the wicking is introduced, to cause the tallow to unite around the wicking, substantially as herein described."

---

20. For *Improvements in the Cooking Stove;* Rensselaer D. Granger, Albany, New York, February 20.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the draught tube, for admitting air to the fire, passing through the flue, in the manner described, by which the air admitted is heated before it reaches the fire.

"I also claim the mode of securing non-conducting substances, herein described, applied in a plastic state, and confined by ribs of metal or grating, as described and represented.

"I also claim the combination of the non-conducting substance forming the back of the oven, and serving the usual purpose of a brick oven for absorption, with the ascending pipes for heating the oven placed inside thereof."

---

21. For an *Improvement in the Machine for Cutting and Grinding Fodder;* J. Jessop, J. Wanbaugh, G. W. Ilgenfritz, and James C. Baker, New York, February 20.

The patentees say,—"The nature of our improvement consists in the manner of arranging the hopper and cylindrical grinders of a

combined machine for cutting and grinding fodder, to prevent the mill from choking, a defect long since experienced and not removed in any of the machines heretofore made for this purpose, with which we are acquainted. In machines heretofore made for this purpose, the grinding cylinders are so placed as to receive the fodder from the cutters between the two cylinders, when two are used, or between the cylinder and concave, when only one cylinder is employed; but to prevent the choking of the mill, which frequently occurs in these arrangements, we discharge the fodder from the cutters into a hopper back of the main grinding cylinder, and in which it revolves, so that by its revolution, the teeth of the cylinder carry up and around, to be ground between it and the second grinding cylinder, the required quantity of fodder, so that the grinding is fed by the main grinding cylinder, instead of the cutting machine."

Claim.—"We do not claim as our invention the combination of grinding cylinders with a cutting machine, for cutting and grinding fodder; but what we do claim as our invention and desire to secure by letters patent, is the arrangement of the hopper back of the main grinding cylinder, in a combined machine for cutting and grinding fodder; so arranged as to cause the main grinding cylinder to take the fodder from the hopper, into which it is discharged by the cutters, and carry it around to be ground, or crushed, between the two, substantially as described."

---

*List of American Patents which issued in the month of April,* 1842, *with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

(Continued from page 40.)

40. For an *Improvement in Fastening Bedsteads;* David Ball, Sandy Hill, New York, April 16.

Claim.—"Having fully described the nature and operation of my bedstead fastening, what I claim therein as new, and desire to secure by letters patent, is the manner of forming the two parts marked (C) and (D), so that an offset on the former shall fit into a recess in the latter, and draw and bind the parts together by rotating the rail to which the parts (C C) are attached, said rail rotating upon pins which enter the posts in the manner set forth. I also claim the particular manner of fastening the head and foot boards by means of metallic clips, and the tongues and grooves, arranged and operating as described."

The pieces indicated in the claim by the letter C are made of metal, secured to the ends of the side rails, and are each provided with a tongue which, on partly rotating the rails, enter cavities in corresponding metal pieces (D) attached to the end rails.

The clips for securing the head and foot boards are metallic sockets attached to the posts, and having sharp projecting ridges inside, so

that, when the boards are forced down into the sockets vertically, these ridges enter cavities in the wood and thus hold the posts together.

---

41. For an *Improvement in Stop Cocks for Tapping Water Pipes, under Hydrostatic Pressure;* Jona Ridgway, New York, April 16.

At the end of that part of the pipe of a stop cock which is to be screwed into the water pipe there is a drill cutter which extends up the sides to cut the thread, so that the hole is bored and tapped, and the cock screwed in at the same operation to prevent the escape of water.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of a cutter with the stop cock or faucet made in any of the usual ways, in the manner and for the purpose herein described."

---

42. For an *Improvement in Horse Shoes for the Cure of Hoof-Bound Horses;* Daniel Homer, Alton, Illinois, April 16.

The patentee says:—"This invention consists in turning the inner parts of the heel of the shoe upwards with the hoof of the animal, so that the shell or horny part thereof shall rest upon the inclined surface of the elevated portion, and thereby cause to open or spread the heel of the foot, which had become so contracted as to pinch and cramp the frog and create soreness and consequent lameness, which has been known and denominated *hoof-bound* disease or complaint.

Claim.—"The part I claim as new and as of my invention, is that peculiar shape of the heel or the part turned upwards into the foot, differing from anything I have ever known to be in use. A slight twist of the heels of shoes has been practised differing from my invention or improvement in effect as well as in shape, the latter producing a cure in a few days, whereas by the former it requires several shoeings and some months' time to remedy the complaint."

---

43. For *Improvements in the Padlock;* William Ball, Washington, District of Columbia, April 16.

Claim.—"What I claim as my invention and desire to secure by letters patent, is

"1st, The principle of locking the shackle, or other similar article by counter weighted vibrating hooks, arranged in alternate order so as to prevent the lock being opened by a blow on the outside, whether constructed and applied in the manner before described, or in any other mode substantially the same.

"2nd, I likewise claim the mode of holding the end of the shackle in the cavity of the hook or tumbler, by means of the latch connected with said hook, and resting under and against the shoulder near the end of the shackle, as described.

"3rd, Likewise constructing the lock with a spring strap for catching or entrapping the key of the lock picker, whether constructed and arranged in the manner described, or in any other manner substan-

tially the same; or whether applied to padlocks or other kinds of locks.

"4th, The inclined end of the shackle in combination with the inclined projection of the hook or tumbler, for the purpose and in the manner set forth."

---

44. For *Improvements in Machinery for setting Logs on the Carriages of Saw Mills;* John Sheffield, Williamson, New York, April 16.

Without drawings we could not give a clearer indication of this apparatus than will be found in the claim, without going beyond our limits.

Claim.—"What I claim as my invention and desire to secure by letters patent, is, first, the method of setting the log for cutting thick or thin boards at pleasure as before described, by means of the aforesaid combination of hands, springs, vibrating crutch, connecting rods, knee, universal joints, and clapper, said hands acting on the toothed slide to which the log is dogged by the clapper striking against adjustable stubs attached to the frame work or timbers of the mill, arranged for various lengths of logs to be sawed. Second, Likewise the combination of the arm, axle, and lever with the vibrating crutch and hands for altering the movement of the slides to saw thick planks or thin boards, at pleasure, as described. Third, The mode of fastening the head block to the carriage by means of the jaws and wedges in the manner described."

---

45. For *Improvements in Bedsteads for Invalids;* William Woolley, New York, April 16.

We are under the necessity of omitting the claim of this patent as it could not be understood without the drawings. It is limited to the combination and arrangement of levers and catches for elevating or depressing different parts of the frame on which the bed rests, to admit of placing the patient in any position desired. Bedsteads of this general character having long since been known and used, the claim is limited to the peculiar arrangement of parts for effecting this end.

---

46. For an *Improvement in Chimney Caps;* Stephen M. Allen, Boston, Massachusetts, April 21.

Claim.—"Having thus fully described my invention, I shall claim —protecting the mouth or leeward end of the discharging pipe of a turning cowle by a hollow cone, the diameter of the base of which shall be somewhat larger than the diameter of the mouth of the discharging pipe; and I also claim the combination of the said cone with the conical air tubes arranged in the interior of the discharging pipe, the whole being constructed and operating substantially as above described."

47. For an *Improvement in the Cooking Stove;* John Brereton, New York, April 21.

The object and nature of this improvement will be clearly understood by the following

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination herein set forth as forming a heated air chamber, over, under, and around the cooking utensils, by the sliding doors, thereby retaining and confining the heat given from the grate below. The oven with the double bottom and other details herein given I do not claim."

---

48. For an *Improvement in the Hydro-pneumatic Lamp;* Stephen S. Lee, Providence, Rhode Island, April 21.

This improvement is for drawing the oil from the lower reservoir of this class of lamps simply by means of a syphon, the outer and long leg of which turns on the other, and when turned down, forms a communication with the reservoir, and when turned up, closes it, to exclude the air.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the application of the syphon, or faucet, or other means substantially the same, to draw the oil from the chamber, and avoid the disagreeable and inconvenient necessity of inverting the lamp every time it is filled."

---

49. For *Improvements in the Machine for Tempering Clay;* Rich. Stillman & Jesse Taylor, Philadelphia, Pennsylvania, April 21.

Claim.—"We do not claim to be the first who have used a tempering wheel, or wheels, made to traverse back and forth on a horizontal shaft; but we do claim to have made a material improvement in the construction of this apparatus, by combining and arranging the respective parts thereof, in the manner described; that is to say, we claim the forming of the iron wheel, with the curved spokes so attached to the hub and to the rim as to leave a space between them. We also claim the manner of causing a wheel, formed as described, to traverse back and forth on a horizontal shaft, by cutting intersecting right and left-handed screws on said shaft, and employing a swivel piece with the hub of the wheel, to take alternately into the threads of said screws, in the manner set forth. We do not claim the use of intersecting right and left-handed screws, in their general application, but only in their combination with a wheel for tempering clay, constructed and operating as herein made known, and actuated by animal or other power."

---

50. For an *Improved Apparatus for Raising Sunken Vessels;* Theo. R. Timby, Auburn, New York, April 21.

The ship is to be raised by means of a vessel attached to it, and from which the water is to be expelled by pumping in air through

the bottom, which is open, to receive the air and permit the escape of the water. These vessels are of a funnel shape, with the large end closed. Metal rods are attached to the top of the cap, (at the large end,) pass over a strong metal ring that surrounds the greatest diameter, and all of them are united with a large ring at the bottom.

Claim.—"I do not claim raising sunken bodies by forcing water out of a floating vessel by pumping air into it, but what I do claim, is the peculiar funnel shape of the air vessel, having a conical cap, over and around which the chains or other fastenings are secured, by which the air vessel is attached to the ship or body to be raised, as described, in combination with the manner of securing the chains, or rods, and passing them over the ring, so as not to injure the air vessel, as described."

---

51. For an *Improvement in the Construction of Umbrellas, &c.;* Gilbert S. Ward, Newark, New Jersey, April 21.

This improvement is applied to that class of umbrellas, the rods or whalebones of which are jointed, to fold over; and the improvement consists in making one of the metal pieces of the joint with a projection, so as to form a support for the other part when the umbrella is opened, and at the same time protect the silk covering.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is constructing the whalebones of umbrellas and parasols with the supporting piece in combination with the joint, as herein set forth."

---

52. For *Improvements in the Power Loom;* James Nield & Caleb Duxbury, Taunton, Massachusetts, April 21.

The claim of this patent refers to, and cannot be understood without, the drawings, the great size of which, and the necessary complexity of the mechanism, preclude the publication at present.

---

53. For *Oiling the Spindles and Tubes of Cap Spinners;* Charles Danforth, Paterson, New Jersey, April 21.

Claim.—"I claim as my improvement a cavity in the top of the cap-top, to hold oil and prevent it from running down on the outside of the cap, in combination with a recess, or groove, between the cap-top and the spindle, to allow the oil to run down to the tube below, essentially as described in this specification."

---

54. For an *Improvement in the Method of Driving the Spindles of the Danforth Cap Spinning Frame;* Charles Danforth, Paterson, New Jersey, April 21.

The spindles, or rather bobbins, are turned by bands running on to a horizontal drum, and the band must, of necessity, be at different elevations. The warves are attached to tubes having blocks projecting upwards, on which the bobbins rest, so that the lengths of these

blocks will enable the constructor to have the bobbins all on the same level, and the warves at different elevations, to be on a line with the bands.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of the tubes (on which warves are affixed, at different heights,) with the blocks or buttons placed thereon, for the purpose of supporting the bobbins at the same height; the whole constructed in the manner and for the purpose herein set forth."

---

55. For an *Improvement in the Reaction Water Wheel;* L. W. & G. W. Blake, Pepperell, Massachusetts, April 21.

Claim.—"What we claim as new, and desire to secure by letters patent, is the placing of the buckets between two plates, so formed that the parts in which they are contained shall constitute the frustrums of cones, the lower or outer plate or plates being left open, for a central discharge between the buckets; said buckets being also so arranged as that their planes shall form a tangent, or nearly so, with a circle of said opening; such wheel or wheels being furnished with a neck, or collar, running truly within or against a metallic plate; and the respective parts of said wheel and its appendages being combined together, and arranged substantially as above set forth."

---

56. For an *Improvement in the Waste Gate of Mills;* E. Eastlack & J. A. Miller, Greenwich, New Jersey, April 21.

The patentees say,—"The nature of our invention consists in applying a combination of buoys and levers, cords and pulleys, to waste and flood gates, in such a manner that the rise of the water over a medium or desired height, shall raise the gates and let the water escape, and thus prevent an overflow, or breaking of the dams or banks."

Claim.—"What we claim as our invention and desire to secure by letters patent, is the particular arrangement of the levers, in combination with the buoys, pulleys, cords, and gate, for the purpose herein specified."

---

57. For an *Improvement in the Smut Machine;* James Durling, Sparta, New Jersey, April 21.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of the smut machine with the scouring stones for flouring mills, as described, and for the purposes herein set forth; distinctly and expressly disclaiming all else."

## BIBLIOGRAPHICAL NOTICE.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Report on the Survey of the Coast of the United States.* By A. D. Bache, L.L. D., *Superintendent.*

We have received the annual report of the Superintendent of the Survey of the Coast of the United States. It is a clear and comprehensive document, of seventy-four pages, showing the progress of that important work, which is advancing in a manner creditable to those engaged in conducting it, and highly advantageous to the country.

No greater boon can be conferred upon American commerce than that of furnishing, at a low price, an ample supply of accurate charts of all our coasts and harbors. We have long been dependent upon old and incorrect maps, often derived from foreign sources, and frequent and fatal marine disasters have been the consequence; but this cause of disgrace to our country is now rapidly diminishing under the exertions of the present efficient administration of the coast survey.

During the past year, operations have been carried on in fourteen States, and the system introduced by Professor A. D. Bache, the present superintendent, of not waiting for the gradual extension of the triangulations of the survey from a single base line, but of carrying on, simultaneously, detached surveys of the most important parts of the coast, which are afterwards connected for mutual verification, has been most advantageously developed. This course of proceeding somewhat adds to the *annual* cost of the work, but it increases the useful results in a vastly greater proportion, and it has both common sense and true economy to recommend it. It may, and probably will, save many a gallant ship and many a valuable life, which otherwise would have been lost before the mapping of the coast had reached the shore on which they might have stranded.

What the mariner wants is accurate knowledge, his safety depends upon it, and yet he has no means of acquiring it for himself. Pilots hand down from father to son the traditions of the channels, rocks, and shoals, which they are supposed to understand, yet often very imperfectly. The labors of the coast survey have already resulted in discovering deep-water channels into the harbors of New York and Philadelphia, the existence of which was not known before. The positions of rocks and shoals and depth of water upon them have been accurately ascertained, and new ones discovered. A shoal off Nantucket has been discovered in the past year "six miles south of any known danger, lying directly in the usual track of vessels between New York and Europe, and in that often followed by coasting vessels between New England and New York, out of sight of land, unmarked and unknown except to the lost." Every one must feel the value of such a contribution to knowledge. The report is illustrated

by nine engraved sketches, showing the progress of the survey, which serve to illustrate the text.

Throughout all the complicated operations connected with the work, from the measurement of the primary base line to the completion of the finished maps, there is required a combination of high scientific knowledge with practical skill, to an extent rarely called for in the execution of any work; and it is fortunate for the country that the Superintendent is a gentleman possessed of all the requisite qualifications for his difficult duties, and not only able to direct his assistants in all things, but always ready to give them, by name, the full credit of any meritorious service that they may render.

The maps which have been published are truly beautiful, and, as the plates can be multiplied to any extent by the electrotype process, they can be furnished in any quantity that may be required by the good of the country at whose expense the work is executed.

## MECHANICS, PHYSICS, AND CHEMISTRY.

*Extract from the Third Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and of various Temperatures, upon Cast Iron, Wrought Iron, and Steel.* *By* ROBT. MALLETT, Mem. Inst. C. E., M. R. I. A.

*Conclusions drawn from discussing the results given in the tables, as regards Iron Ships.*

Continued from page 133.

The next part of the process consists in covering the iron with the preservative alloy, which is to be prepared in the following manner: Zinc is to be melted in a suitable vessel, which is best of pottery or stone; and when in fusion mercury is to be added to it, in the proportion of 202 parts of mercury to 1292 parts of zinc, both by weight; that is, 40 atoms of zinc to 1 of mercury, or thereabouts. These are to be well stirred or mixed together with a rod of dry wood, or of iron coated with clay. To the above alloy is now to be added either potassium or sodium, in the proportion of one pound to every ton weight: the alloy of either will answer the purpose, but I prefer sodium, as more easily obtained and more manageable. These metals are usually preserved from oxidation in naphtha, or some other fluid not containing oxygen. They are to be removed from this in small portions, not more than half an ounce at a time, placed in a small inverted cup of wood formed on the end of a stick, and thrust rapidly below the surface of the alloy of zinc and mercury, with which either may be made thus to combine easily, and without loss or combustion of the alkaline metal. The triple alloy thus formed of zinc, mercury, and sodium or potassium, after having been again stirred and mixed with the dry wood rod, is ready for coating the prepared iron when

immersed in it. The combination of these metals is facilitated, and their oxidation on the surface retarded, by strewing upon it some of the salts contained in solution in the "preparing bath" when in a dry state.

The plates of iron or other articles are now to be taken up out of the "preparing bath," permitted to drain for a few seconds, and immediately, while still wet with the liquor, immersed in the fused alloy; and as soon as they have acquired its temperature, which should not be raised higher than is necessary for fusion, they are to be withdrawn again edgewise, and will be found covered with a perfectly uniform and coherent coat or surface of the alloy.

The affinity of this alloy for iron is so intense, and the peculiar circumstances of surface induced by the preparing bath upon the iron presented to it are such, that care is requisite, lest, by too long an immersion, the plates or articles of iron should be partially dissolved; and where the articles to be covered are small, or their parts minute, it is necessary, before immersing them, to permit the alloy to dissolve or combine with some wrought iron, in order that its affinity for iron may be partially satisfied, and so this risk be avoided. The alloy will, at its proper fusing temperature, which is about 680° Fahr., dissolve a plate of wrought iron of an eighth of an inch thick in a few seconds, and form with it a quadruple alloy.

More or less mercury, and more or less of the alkaline metals may be used in forming this alloy, but the proportions given are those I have found best, as the alloy is permanent at its temperature of fusion; *i. e.*, no mercury is lost by volatilization, nor does the alloy show any inconvenient tendency to oxidation, much less indeed than common zinc does at the surface, which is, in the case of the alloy, to remain covered with any oxide produced, and with the dry salt, the double chloride of the preparing bath transferred to it on the pieces of iron, as these defend it from the action of the atmosphere. It is desirable that the melting vessels should be as deep, and expose as small a surface, as the nature of the articles to be immersed will allow. At the moment of immersion of a plate or other article of iron, the surface of the alloy is to be cleared of all dross or oxide by a wooden skimmer.

As soon as the iron is withdrawn from the alloy, it is to be plunged into cold water and well washed therein. The surface of the iron is now in a condition to resist corrosion.

By the addition of a larger portion of mercury to the before mentioned alloy of zinc, mercury, and sodium or potassium, cast or wrought iron, or steel, may be coated therewith at a lower temperature, or even cold, by simple contact accompanied with friction; but a smaller quantity of mercury than that before given, will often be found most convenient.

In the case of iron ships the foregoing operations are best performed upon the plates and ribs after they have been all bent and fitted to their places, and the plates riveted together into large pieces of eight to ten feet square, or more, which, when again put "into frame," or placed in their respective positions in the ship's hull, are to be united by rivets countersunk from the outside, and hence closed inside the vessel.

The countersunk heads of these rivets should be also coated with the alloy; and I have mentioned in detail elsewhere how these may be heated for riveting without injuring the alloyed head.

The hull of the iron vessel being thus completed and wholly covered with the alloy, is now to receive a coat of varnish all over of the composition about to be described, and which is best laid on with a spatula, or thin flexible blade of iron, as a brush produces minute air-bubbles, which leave spaces uncovered on the drying of the varnish.

The varnishes described will dry, or get hard and coherent at ordinary temperatures, but where convenient, it is desirable to expose them for some hours to a temperature of about 300° Fahr., which gives them greater adhesion and durability.

To form the varnish No. 1, take 50 pounds of foreign asphaltum, melt and boil it in an iron vessel for three or four hours, adding gradually, in fine powder, 16 lbs. of red lead and litharge ground together in equal proportions, with ten imperial gallons of drying linseed oil; bring all to a boiling temperature, melt in a separate vessel 8 lbs. of gum anime, (which need not be of the clearest or best quality,) add to it two imperial gallons of drying linseed oil, boiling, and 12 lbs. of caoutchouc, softened or partially dissolved by coal-tar naphtha, (as practised by the makers of water-proof clothes;) mix all together in the former vessel, and boil gently until, on taking some of the varnish between two spatulas, it is found tough and ropy. When this "body" is quite cold, it may be thinned down with from thirty to thirty-five gallons imperial of turpentine, or of coal naphtha.

This is the best varnish I am acquainted with for the purpose of covering iron; it is not acted on, when dry and hard, by any moderately diluted acid or caustic alkali; it does not, by long immersion, combine with water, and form a white and partially soluble hydrate, as all merely resinous varnishes and all oil paints do, and it is so elastic that a plate covered with it may be bent several times without its peeling off; and lastly, it adheres so fast that nothing but a sharp-edged instrument will scratch it off the surface of iron.

The varnish No. 2 is of a cheaper sort, but not quite so good. Common coal or gas tar is to be boiled in an iron caldron, at so high a temperature that the smoke from it is of a yellow dun color, or the tar is to be caused to flow through red-hot iron tubes. The boiling is to be continued until the residue is a solid asphaltum, breaking with a pitchy fracture. It is essential that the boiling should be carried on at this high temperature, as the permanency of the varnish in water depends upon the tar having been submitted to the temperature at which naphthaline is formed by the decomposition or breaking up of the original constitution of the tar.

Take 56 lbs. of this coal-tar asphaltum, melt it in an iron vessel, add ten imperial gallons of drying linseed oil, ground with 25 lbs. of red lead and litharge in equal proportions; add to the whole, when well mixed, and after boiling together for two or three hours, 15 lbs. of caoutchouc, softened or partially dissolved by coal naphtha, (as before described;) when cold, mix with twenty to thirty gallons of turpentine or coal naphtha, and the varnish is ready for use.

Either of these varnishes is to be applied over the whole surface of the iron and suffered to dry; and as this forms the final preservative coat upon all articles except iron ships, buoys, &c., requiring to be preserved from "fouling," any desirable color may be given to it by coloring materials, which should be peroxides not acted on by air and water.

The last operation, viz. that to prevent "fouling," now remains to be performed upon ships, &c.; for this purpose a strong-bodied thick paint is to be made with drying linseed oil, red lead, and sulphate of barytes (or white lead may be used, but not so advantageously,) and a little turpentine. To every 100 lbs. of this paint, when mixed, is to be added 20 lbs., or thereabouts, of oxychloride of copper, and 3 lbs. of a mixture composed of hard yellow soap, melted with an equal weight of common resin and a little water.

The color sold in commerce originally under the name of Brunswick green was an oxychloride of copper. The Brunswick green of commerce at present is a different thing, but the oxychloride of copper may be obtained at a cheap rate by various known methods, which it is unnecessary to detail. With this paint the whole *immersed* hull of the vessel is to be coated over the before-mentioned varnish; it must then be permitted to dry and stiffen for three or four days before the ship is floated out of dock. The operations are now completed, and the hull of an iron ship so treated will resist "corrosion" and "fouling."

The principles upon which this method of protection rests may be thus stated:—By the use of the "preparing bath," the surface of iron, of whatever sort, is more effectually cleansed than has before been practicable, and all minute particles of foreign matter removed from the surface; and by the reactions which take place in the "preparing bath," in which *metallic amides* are formed, and hydrogen evolved at the surface of the iron, a powerful tendency is given to the iron to combine with other metals. Again, by the presence of the small quantity of sodium or potassium in the alloy, a greatly increased tendency to combine with iron is conferred upon *it*, while any minute portions of oxide, either suspended in the fluid alloy, or which have escaped the previous operations upon the surface of the iron, are reduced to metal. Thus both metals are presented to each other in a state of absolute purity, and in the most favorable circumstances for combination.

But further, when the alloy, or generally any alloy of mercury with metals electro-positive to it, is exposed to the action of a solvent, the positive metal at the surface is first acted on, and the surface becomes shortly covered with pure mercury. The result, therefore, of the primary reaction of air and water on this alloy is, that the coating of the iron becomes covered with a very thin film of *amalgamated zinc*, which is known not to be acted on by fluid menstrua, except under peculiar conditions. I found no calcareous coating formed on such a surface in sea or fresh water. The varnish laid over this is intended as a sheathing, to give additional durability and mechanical protection;

and also in the case of iron ships, to interpose between the covering of alloy and the final coat of poisonous paint.

It was stated by Sir H. Davy, in his researches on the preservation of copper sheathing, that the sole cause why it did not become "foul" when unprotected was, the continual loss of substance by solution and washing away of the salts produced (the suboxide and oxychloride of copper,) and that the poisonous properties of the salts produced had nothing to do with the matter. The only proof, however, given of this was, that fouling rapidly took place upon a surface of *lead* forming a portion of a coppered vessel's hull, upon which there existed an abundant production of carbonate of lead. Although fully aware of the powers of endurance possessed by the classes of animals which adhere to ships, such as those of the genera *Balanus, Otion, Ascidia, Cineras, Anatifa, Ostrea, Mytilus, Dreissena,* &c., still I doubted this conclusion, from remarking that they adhered to the surface of metals, such as zinc in a rapid state of degradation or solution in sea water, but which did not produce poisonous salts.

I also observed, that to perfectly clean metallic surfaces they showed little disposition to adhere; that either a thin coat of peroxide, or of calcareous matter deposited from the sea water, was necessary to their adherence; that the testaceous animals seemed to disregard the nature of the metal to which they clung, provided they had a coating of calcareous matter to adhere to, and that the same applied to a great extent, to the growth of sea-weeds.

I thence determined to make some direct experiments upon the effects of metallic poisons upon such common molluscous or testaceous animals as I could command, and for this purpose I chose the common oyster, the limpet, *(Patella,)* and some of the *Actiniæ* found along the shores of Dublin bay; these were placed in glass vessels of sea water frequently renewed, and left for some time without disturbance, until it was certain that the condition of the animals was not in itself fatal or injurious to them. Then certain poisonous metallic salts were gradually introduced into their respective receptacles, such as the soluble and insoluble salts of lead, copper, mercury, arsenic, &c.

The results of these experiments, which were continued for a long time and made with care, showed that all these animals were more or less subject to annoyance from substances poisonous to the higher animals; that they were least affected by the salts of lead and mercury, and most so by those of copper; and that, unless present in such large quantity as to be at once fatal, the insoluble, or rather difficultly soluble, salts of copper in sea water, (such as the oxychlorides and the arsenite of copper,) gave them much more uneasiness than the soluble ones. The poisonous matter, when difficultly soluble, was sometimes merely dropped into the sea water near the animal, at others, was strewed upon a plate, and the animal placed upon it. In every case, when the animal was killed, the poisonous matter, (at least the copper, which was the only metal looked for,) could be detected in its body after death.

From these experiments, I think I am justified in concluding that the other classes of "fouling animals, whose habits are so analogous

to those tried, are prevented from adhering to copper sheathing in virtue of the poisonous salts produced by the sea water acting upon it, and not merely by loss of continuity; and that in the case of the lead cited by Davy, the animals adherent must have been protected from the poisonous surface by a coat of calc-spar or carbonate of lime formed upon it, or by some other unexplained circumstance; and that hence the production of an artificial poisonous surface upon the bottom of an iron ship, a buoy, &c., would prevent their "fouling" also.

I also made some experiments upon the effect of metallic poisons upon sea-weeds, choosing for this purpose portions of *Fuci* adherent to small loose pebbles, and thus capable of transfer to a glass vessel. The results here were not so distinct as with the animals, but proved that copper salts in solution were decidedly deleterious to their existence. I ascertained also that marine plants would with the greatest difficulty attach or grow upon greasy or varnished substances free from any film of calcareous matter or oxide of iron.

From these experiments, I have been led to propose the peculiar poisonous paint, already described, as a preventative to "fouling" of iron ships; it is in fact a method of bringing their immersed surfaces as nearly as possible to the condition of a copper-sheathed vessel, without injury to the iron. The paint, therefore, is only a vehicle for poisonous matter, for which purpose it is requisite that it should have sufficient adhesion to resist the ship's motion, but still should have a slight degree of solubility in water, so that the poisonous matter may be taken up by the absorbent or capillary vessels of an adhering animal or plant. This latter property is given it by the addition of the resinous soap, the proportion of which must be varied to suit frigid or tropical climates. I prefer using the oxychloride of copper as the poisonous matter of this paint; indeed it is simply the formation of this salt that prevents "fouling" of ordinary copper sheathing, but other salts will answer the purpose.

The cost of protecting, by the methods described, the hull of an iron ship, of say 130 feet keel, materials and labor included, and preparing her against fouling, would add about ten shillings per ton to the cost of her hull, an amount quite inconsiderable when balanced against durability, safety, and speed.

When no attempt is made to procure complete protection from corrosion, a considerable palliative consists in heating all the plates before being put together to nearly a "black-red" heat, in a boiler-maker's oven, immediately plunging them into boiled coal tar, and taking them out while still warm, so that a firm varnish may form upon them; but spots of rust soon appear even upon plates so treated.

It is very desirable in every iron ship, that a layer of felt saturated in coal tar, boiled to the consistence nearly of pitch, should be interposed between not only every metallic body electro-negative to iron, as before observed, but also between *every* piece of timber, of whatever sort, placed in contact with the hull below the water-line, and most especially in the bilge. Besides obvious mechanical reasons, this is important from the fact that as soon as timber begins to decay in contact with iron and sea water, the rotten wood possesses the

power of decomposing the sulphate of lime of the sea water, reducing it to sulphuret, while carbonic acid evolved from the decayed timber again decomposes the latter, producing sulphuretted hydrogen, which corrodes the iron locally with great rapidity.

Soft wood not only rots soonest, but decays in a way that produces these effects more rapidly than the harder timber; this fact I would press upon the attention of iron ship-builders.

These remarks might be extended, with many others of importance to the practical constructor, but for which this is not the place.

In conclusion, when the durability of iron vessels, as regards corrosion, and this is admitted alone to limit their existence, is compared with that of timber ships in reference to their decay, the balance undoubtedly seems at first in favor of the latter. We have examples of ships, such as the Royal William, built in 1719, lasting more than one hundred years; the Sovereign of the Seas, built in 1639, forty-seven years; the Barfleur, built in 1768, more than forty-four years, &c.; but these are the rare exceptions, not the rule.

The Commissioners of Woods and Forests, in their "Report of 1812, on Timber for the Navy," estimated the average duration of a ship at fourteen years, while other authorities take it at twelve and a half years. Frigates, when built of American red pine, seldom lasted longer than five years, and the Ocean, Foudroyant, St. Domingo, Rodney, Ajax, and Albion, new ships, all fell to pieces from dry rot in about four years.

Were it the fact, therefore, that unprotected iron vessels corroded equally throughout every part immersed, we could easily calculate, by the aid of our preceding researches, the durability of a ship of given scantling and predetermine, under such and such conditions, at what time her hull would have become dangerously thin, and might rest with the assurance that for this period the iron ship was the best and safest that could be put upon the waters; but unfortunately we have found that corrosion does not take place with perfect uniformity, as has been already pointed out; and hence, without protection, ships of iron must be always liable to the dangerous consequences of local corrosion and consequent thinning down of iron at particular spots, until, at some unforeseen moment, possibly of least preparation and greatest external peril, a decayed plate is burst through and the vessel fills. The facility of introduction of water-tight bulk heads in iron ships greatly reduces the danger of such an accident, but it must always be attended with danger and loss of property, and occurring where it is most likely to happen, namely, in the engine compartment of an iron steamer in bad weather, would be almost certain to involve the loss of the ship.

The more sanguine advocates of iron ship-building have, in their anxiety to prove their durability to be such as to render protection needless, appealed to the existence of iron canal boats of 40 years of age or more, and to some of the earliest built iron vessels, which have been occasionally in salt water. Most of the vessels alluded to, however, have been principally in fresh water, and on referring to Table XV, it will be obvious how vast a difference there is in the durability

of a ship of any given sort of iron, exposed to the action of sea and of fresh water. Thus, suppose a vessel of Low Moor plates; in one century the depth of corrosion would be—

| | Inch. |
|---|---|
| In clear sea water, . . | 0·215 |
| In foul sea water, . . | 0·404 |
| In clear fresh water only, . | 0·035 |

In other words, while the ship, if originally of half-inch plates, would be almost destroyed in foul sea water, it would not have lost one-tenth of its scantling, in clear fresh water in the same time. These cases, therefore prove nothing to the point.

It therefore seems to me that protection against local corrosion and "fouling" is essential to the safety and perfection of iron ships, and is alone wanting to render our future iron ships as much safer and more enduring than those of timber, as the steam ship of to-day is safer and more enduring than the sailing vessel of two centuries ago.

The mechanical methods which have been proposed for removing foulness from the bottoms of iron ships, namely by scraping with a large wooden frame drawn under the hull by suitable rope tackle, appears quite incapable of removing more than the mere exterior fringe as it were, of the "foulness," or some of the larger animals when once become adherent. The force with which both animals and plants adhere to the coat of calcareous and rusty matter on an iron plate is very great, and no instrument sufficiently sharp, and pressed hard enough to the ship's hull, could probably be successfully used, unless of iron, and this would be liable not only to injure the surface, but become constantly caught against small projections of the ship's bottom.

But even were some methods of scraping possible, it only temporarily removes the evil, leaving its cause untouched; and that this cause is in such rapid operation, at least in some localities, as to be a most serious evil, may be illustrated by the following observations:—

Stevenson, in his account of the Bell Rock Lighthouse, mentions that the bottom of the temporary light-ship, after being newly caulked and pitched, was found covered over with mussels *(Mytili)* three and a half inches long, in three years and seven months from the time she was moored off the Bell Rock.

It is stated in the transactions of the Wernerian Society, vol. ii, p. 243, that the spawn of the Cirrhipoda class of fouling animals became developed upon a *feather*, on which it lay before the latter had decayed in sea water, and that they will cover a ship's bottom in a few months.

These observations apply to wooden vessels, and the prevalent opinion seems to be, that iron ships "foul" even more rapidly than these do in similar circumstances.

The opinion that iron vessels, as well as railway bars, receive some hidden power of resisting corrosion when in use, which they lose at other times, has been before alluded to.

The origin of this view with respect to rails is obscure. Wood, in

his "Treatise upon Railways," quotes a Report of Mr. G. Stephenson, in which the following passage occurs:—

"One phenomenon in the difference of the tendency to rust between wrought iron laid down as rails and subjected to continual motion by the passage of the carriages over them, and bars of the same material either standing upright, or laid down without being used at all, is very extraordinary.

"A railway bar of wrought iron laid carelessly upon the ground, alongside of one in the railway in use, shows the effect of rusting in a very distinct manner; the former will be continually throwing off scales of oxidated iron, while the latter is scarcely at all affected."

This is the first notice I have found of this opinion, which has since been repeated in various quarters, but *no fact*, that I am aware of, has been given to support the view which a mere casual inspection of rails so situated suggests.

When rails lying parallel on the same line of way, but one set in and the other out of use are examined, appearances do undoubtedly seem to support the opinion. The unused rails are found covered with red rust, often coming off in scales parallel to the surface, while those in use present a light brown or buffish coat of rust, without any loose scales. I am much disposed, however, to believe that there is no real difference in the amount of corrosion in the two cases, and that the difference in appearance arises partly from a *deceptio visus*, by the effect of the bright and polished upper face of the used rail, (kept so by constant traffic) contrasted with the rusty face of the unused rail, and partly from the fact that, as fast as rust is formed upon the rail in use, it is shaken off by the vibration of passing trains, and blown away by the draught of wind which accompanies their motion, and that the rail is soiled and partially blackened by coke, and other dust, &c.

Recently the assumed difference in rate of corrosion has received a new version; it has been stated that rails in use *do* corrode, as well as those out of use, provided the traffic pass over them in both, that is, in opposite directions, as on a single line of way, but do not corrode, if the traffic be confined to one direction. These results have been attributed to some undescribed and occult magnetic action.

Whether either or any of these views be correct or not, I am unable at present to say, but as the subject is not only interesting in a scientific point of view, but of practical importance, and as no correct measures as yet exist, or at least have been published, of the amount of loss of metal by oxidation and abrasion of railway bars, I have thought it desirable to institute some experiments to determine, first, whether there be any difference in the amount of corrosion of rails in and out of use; secondly, if there be any, to discover on what the effect depends; thirdly, to distinguish numerically between the loss due to corrosion, and that due to abrasion by traffic.

These experiments I have been enabled to commence on the Dublin and Kingstown railway, by the favor of the directors of that line, and hope soon to have others in operation upon the Ulster railway, which is a single line, with traffic, of course, in both directions over

the same rails. I have not, as yet, obtained any results (from insufficient lapse of time,) which I can consider trustworthy, but so far I have not been able to recognize any distinct difference of corrosion between the used and unused rails; on a future occasion, however, I hope to be able to lay my results fully before the Association.

With this exception, and a few others merely of scientific interest, the present Report completes the investigation of all the more important practical desiderata on the subject of the corrosion of iron, &c., entrusted to me by the British Association, and I hope that as the information obtained by its liberal assistance becomes more known, it will be found of practical use by all who are engaged in the constructive use of iron, the substance perhaps the most valuable and important of all those with which Providence has endowed us.

*Note by the Author.*—Since the preceding Report was sent to press, I have learnt with satisfaction that the principles therein developed for preventing the fouling of iron ships, have been already acted on; that the Iron Queen and the Ben Ledi iron steamer have been coated with a composition of tallow, bright varnish, arsenic, and, I believe, sulphur, and that in the former case all fouling was prevented; and after the vessel had made two voyages to the tropics, she was found perfectly clean when docked on her return.

From the bottom of the Ben Ledi ten tons weight of mussels and barnacles are stated to have been removed previous to the application of the above poisonous varnish, which, although different from that I have recommended, not so efficacious, and not harmless as regards its reaction upon the iron hull, is still quite identical in principle with mine. R. M.

*June* 26, 1843. [Trans. of British Assoc.—Civ. Eng. & Arch. Journ.

---

*On certain improvements in the Construction and Supply of the Hydro-oxygen Blowpipe, by which Rhodium, Iridium, or the Osmiuret of Iridium, also Platinum in the large way, have been fused.* *By* Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania.

While a pupil of my predecessor, Dr. Woodhouse, in the year 1801, having observed that a jet of hydrogen when inflamed in atmospheric air, of which only one-fifth is oxygen, was productive of a heat of pre-eminent intensity, I was led to infer that in combining with pure oxygen, the gas, in question, ought to produce a temperature at least five times as great. This led to the contrivance of two modes of producing a jet consisting of a mixture of hydrogen with oxygen. Agreeably to one mode, the gaseous currents meeting like the branches of a river, were made analogously to form a common stream. This object was accomplished by means of perforations drilled in a conical frustrum of pure silver, so as to converge until met by another shorter perforation, commencing at the opposite surface, and so extended as

to join them at the point of their meeting. The other mode was that of causing one tube to be within another, so as to be concentric; the outer tube being a little the longer of the two, the latter being employed for hydrogen, the former for oxygen.

In the year 1814, this last mentioned mode was improved, so as to have the means of securing, by adjusting screws, the concentricity of the tubes, and varying the distance of the orifice of efflux of the inner tube from that of the other.

The constructions employed in 1801, were described and published in a pamphlet, and afterwards republished in Tillock's Philosophical Magazine, vol. xiv., and in Annales de Chymie, vol. xlv. At the same time an account was given of the fusion of pure lime and magnesia, and of the fusion of platinum. Subsequently in a paper published in the Transactions of the American Philosophical Society, it was mentioned that I had volatilized platinum.

About the year 1811, Professor Silliman, in a memoir read before the Connecticut Academy of Sciences, gave an account of a series of experiments, in which the experiments which I had performed were repeated, and many additional fusions made. I had adverted to the intensity of the light produced during the exposure of lime to the flame. Alluding to the heat and light, my words were "the eyes could not sustain the one, nor the most refractory substances resist the other." The intensity of the light was still more insisted upon by Silliman.

My experiments were also repeated by Mr. Rubens Peale, during many successive years, at the Philadelphia Museum, for the amusement of visitors.

About the year 1813-14, it was ascertained, at the laboratory of Dr. Parrish, that a bladder being supplied with a mixture of hydrogen and oxygen, in due proportion, and punctured by a pin, while subjected to compression, on igniting the resulting jet, the gas within the bladder did not explode. Of course a burning jet of flame thus created, was found competent to produce, while it lasted, the same effect as when otherwise generated by the same gaseous mixture.

Soon after this result was obtained, Sir Humphrey Davy discovered, that if a lamp flame be completely surrounded by a gauze of fine wire, it may be introduced into an inflammable gaseous mixture without causing it to explode. This was ascribed to the refrigerating influence of the metal, keeping the gaseous mixture below the temperature requisite for inflammation. Hence it was inferred, that if a mixture of hydrogen and oxygen, while condensed within a suitable receiver, were allowed to escape through a capillary metallic tube, so as to form a jet, this might be made to burn without communicating ignition to the portion remaining in the receiver.

By means of an apparatus contrived agreeably to this idea, Dr. Clark of Cambridge, England, repeated the experiments, made many years before by Silliman and myself, without any other reference to ours, than such as was of a nature to do injustice. An exposition of the invalidity of Dr. Clark's pretensions to originality was made in

Silliman's Journal for 1820, vol. ii., and in Tillock's Philosophical Magazine, for 1821, vol. lvii.

The light produced by the hydro-oxygen flame with lime having been observed by Lieutenant Drummond, of the British Navy, was ingeniously proposed by him, as the mean of illumination in light houses, and has been, in consequence, subsequently used as a substitute for the solar rays, in an instrument known as the hydro-oxygen microscope, which is a modification of that which has been called the solar microscope. The name of Drummond light has consequently been given to a mode of illumination, which I originally produced as above stated.

The instrument which was used by Professor Silliman and by Rubens Peale, was that above described as having two perforations meeting in one. In this form it was, I believe, employed by Dr. Hope, of Edinburgh, and Dr. Thompson of Glasgow, who both treated it as my contrivance, anteriorly to the publication of Dr. Clark's memoir.

The other form, consisting of two concentric pipes, was modified by a Mr. Mangham, with the view of producing a lime light for the microscope above alluded to. When I saw Mr. Mangham at the Adelaide gallery in 1836, he treated this instrument as mine, in another form. I was surprised afterwards to learn that he had obtained a premium for this modification from the British Society for the Encouragement of Arts, without any allusion to the original inventor.

After my return from Europe in 1836, I was very much in want of a piece of platinum of a certain weight, while many more scraps than were adequate to form such a piece were in my possession. This induced new efforts to extend the power of my blowpipe; and after many experiments, I succeeded so as to fuse twenty-eight ounces of platinum into one mass.

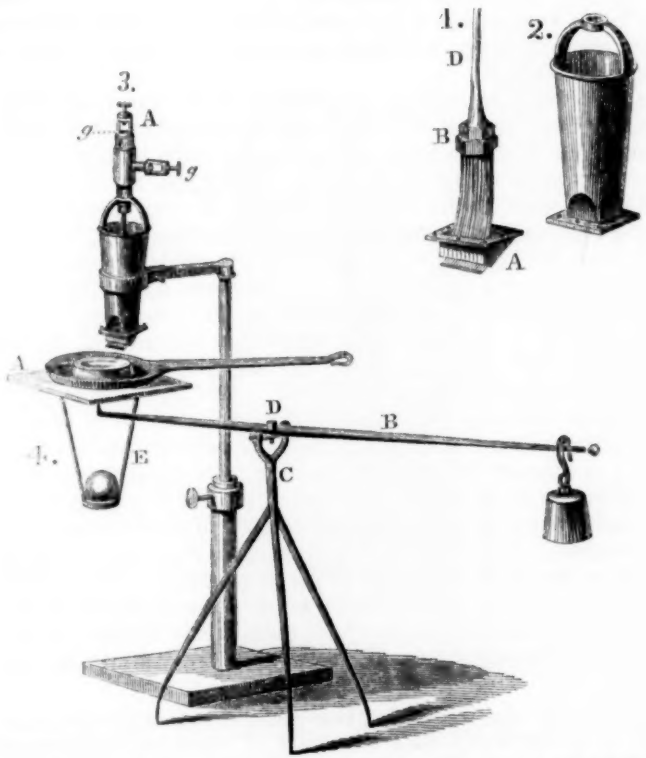
Although small lumps of platinum had been fused by many operators, with the hydro-oxygen blowpipe, as well as myself, it had not, up to the year 1837, been found sufficiently competent to enable artists to resort to this process. I am informed by Mr. Saxton, that some efforts which were made while he was in London were so little successful, that the project was abandoned. There was an impression that the metal was rendered less malleable when fused upon charcoal, as in the experiments alluded to. This is contradicted by my experiments, agreeably to which fused platinum is as malleable as the best specimens obtained by the Wollaston process, and is less liable to flake. The celebrated Dr. Ure, on seeing the platinum in the forms of wire, of leaf, and plate, said that there was no one in Europe who could fuse platinum in such masses. He also alleged that it had been found so difficult to weld platinum, that no resort was had to that process. In this I concur, having had the welding tried by a skilful smith, both with a forge heat, and with a heat given by the hydro-oxygen blowpipe. An incorporation of two ingots was effected on their being hammered together, when heated nearly to fusion; but on hammering the resulting mass cold, a separation took place along the joint by which the ingots were united.

The difficulty seems to arise from the rapidity with which the pla-

tinum becomes refrigerated. It seems to have a less capacity for heat than iron, and, not burning in the air as iron does, has not the benefit of the heat acquired by iron from its own combustion with atmospheric oxygen.

Latterly, by means of the instrument and process which it is my object here to describe, I have been enabled to obtain malleable platinum from the ore directly, by the continued application of the flame. From some specimens of platinum I have procured as much as ninety per cent. of malleable metal. The malleability is not inferior to that of the best specimens obtained, by reducing it to the state of sponge, through the agency of aqua regia and sal ammoniac. There is, however, a greater liability to tarnish, arising, probably, from the presence of a minute portion of palladium.

Of the fusion of iridium and rhodium, I have already given an account in the Bulletin of the Society, which was subsequently embodied in an article prepared for Silliman's Journal for October last, 1846.*




It remains now to give an account of the apparatus employed in the fusion of platina on a large scale.

Fig. 1 represents the association of fifteen jet pipes of platina with

* Since published in the Revue Scientifique at Paris.

one large pipe, B, D, at their upper ends, so that their bores communicate, by means of an appropriate brass casting, with that of the large pipe, the joints secured by hard solder. Their lower extremities are made to protrude about half an inch from a box, A, of cast brass, their junctures, with the appropriate perforations severally made for them, being secured by silver solder. They come out obliquely in a line along one corner of the box, an interval of about a quarter of an inch alternating with each orifice. By means of flanges, the brass box is secured to a conical frustrum of copper, fig. 2, so as to form the bottom thereof, while the pipe, extending above the copper case, is screwed to a hollow cylinder of brass, A, fig. 3, provided with two nozzles and gallows screws, *g*, *g*, for the attachment of appropriate hollow knobs, to which pipes are soldered, proceeding from the reservoirs of oxygen and hydrogen. Cocks are interposed by which to regulate the emission of the gases in due proportion.

In connecting the pipes conveying the gases with the brass cylinder, A, fig. 3, care should be taken to attach that conveying oxygen to the upper nozzle, while the other, conveying hydrogen, should be attached to the lower nozzle; since, by these means, their great difference in density, tends to promote admixture, which, evidently, it must be advantageous to effect.

The object of surrounding the jet pipes with water, by means of the copper box,* is to secure them against being heated to such a degree as to cause the flame to retrocede and burn within them, so as finally to explode within the cylinder, A, *g*, *g*, fig. 3. It is preferable to add ice or snow to the water, in order to prevent undue heat.

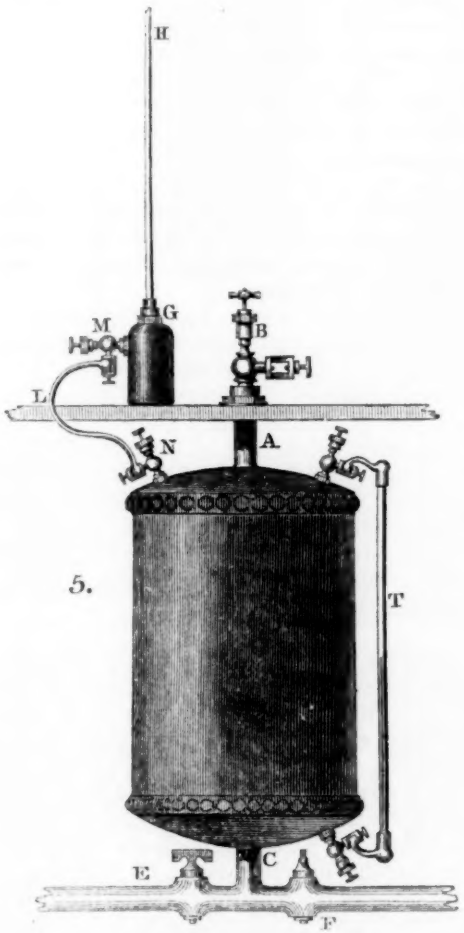
Fig. 4 represents a movable platform, A, of cast iron, wholly supported upon the point of the iron lever, D, B, which is curved towards the extremity under the platform, so as to point upwards, and to enter a small central conical cavity made for its reception. The lever is supported by a universal joint upon the fulcrum, C, so that by means of the sliding weight at one end, the platform and its appurtenances are counterpoised at the other. The platform is kept in a horizontal position by the cannon ball, supported in a sort of iron stirrup terminating in a ring, in which the ball is placed. Upon the platform is situated an iron pan with a handle, holding the brick, on a cavity in which, as already mentioned, the metal is supported. The apparatus being duly prepared, and connected with the supply pipes, the hydrogen is first allowed to escape, and then the oxygen, until the ignition has attained apparently a maximum. The accomplishment of this object may, of course, require the adjustment of either cock several times, especially where there is any decline in the pressure either of the one or the other gas in its appropriate reservoir.

* Since the engraving was made, I have preferred to use water-tight boxes, with gallows screws and nozzles, situated one near the bottom on one side, the other on the opposite side near the top. By means of the lower nozzle, a pipe is attached, communicating with a head of cold water, the other being so situated as to carry the water into a waste pipe, or large tub, a circulation may be kept up during the whole time that the operation is going on.

As a support, a brick of kaolin is used, having an oblong elipsoidal depression on the upper face for the reception of the metal to be fused.

By means of the handles of the lever and of the pan, the operator is enabled to bring the metal into the position most favorable for the influence of the heat, while his hands and face are sufficiently remote to render the process supportable. In fusing any quantity, not being more than four ounces, the platform may be dispensed with, the handle of the pan being held in one hand of the operator, while by the other, the cocks may be adjusted.

When the blowpipe of fifteen jets, or any larger, may be employed, and the platform is necessarily resorted to, the cocks must be adjusted by an assistant.




5.

Fig. 5 represents a cask made of boiler iron, three-sixteenths of an inch thick, so as to resist an enormous pressure. The joints are secured by riveting, as in constructing high pressure boilers.

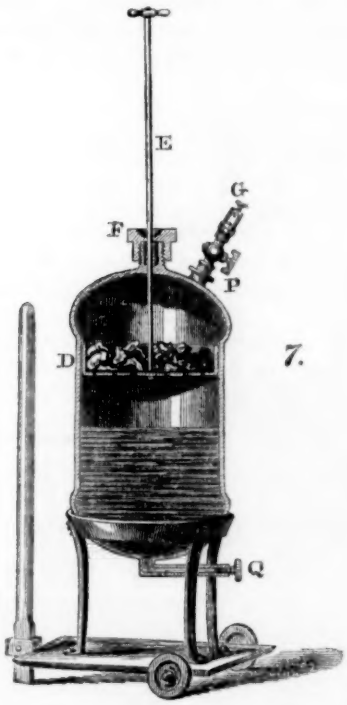
This cask communicates with the hydrant pipes, so called, by which our city is supplied with water, of which the pressure varies from a half to more than two atmospheres, say from seven to thirty pounds per square inch, according to the number and bore of the cocks from which the water may be flowing at the time, for the consumption of the community. Hence, experiments, while using this head, are best made towards bed-time, or between that time and sun-rise. The vessel is filled with water by opening a cock, F, on one side of the pipe C, and allowing the air to escape through the valve-cocks, B. Being thus supplied the cock, F, closed, and a communication with a bell glass, into which oxygen is proceeding from a generating apparatus, being made by means of a flexible leaden tube, on opening the valve cock, B, and the cock, E, the water will run out, and be replaced by gas from the bell. This process being continued till the iron cask is sufficiently supplied with gas, the cock, E, must be shut. Whenever the gas is wanted for the supply of the blowpipe, it is only necessary to establish a communication between the valve-cock, B, and the upper gallows screw, fig. 3, of the cylinder A, and to open the cock, F, so as to admit the water to press upon the gas, the efflux being regulated by B, or preferably by a cock of the ordinary construction, one of which kind should be interposed at a convenient position between the valve-cock, B, and cylinder A.

T, represents a glass tube, which, by due communication with the interior, shews the height of the water, and consequently the quantity of gas in the vessel.

G, H, represents a gauging apparatus, consisting of a cast iron flask, of about a half a pint in content, and a glass tube of about a quarter of an inch in bore, which should be at least five feet in height. The tube is secured air-tight into the neck of the flask, so as to reach nearly to the bottom within. The flask is nearly full of mercury. Under these circumstances, when a communication is made, by a leaden pipe between the cavity of the flask and that of the reservoir, an equilibrium of pressure resulting, the extent of the pressure is indicated by the rise of the mercury in the tube.

In order to generate hydrogen for the supply of a reservoir like that represented by the preceding figure, I have employed the vessel represented by fig. 7. This vessel, by means of a suitable aperture, susceptible of being closed by a screw plug, is half filled with diluted sulphuric acid. Being furnished with a tray of sheet copper, D, punctured like a coal sieve, and supported by a copper sliding rod, E, strips of zinc are introduced in quantity equal to the capacity of the tray. The sliding rod passes through a stuffing-box, F, at top of the reservoir, so that the operator may, by lowering or raising the tray, regulate or suspend the reaction between the zinc and its solvent, accordingly as the supply of hydrogen is to be produced, suspended, increased, or diminished.

The communication with the reservoir is opened and regulated by means of the cock, P, furnished with a gallows screw, G, for the attachment of a leaden pipe, as above described, in the process for supplying the reservoir with oxygen.



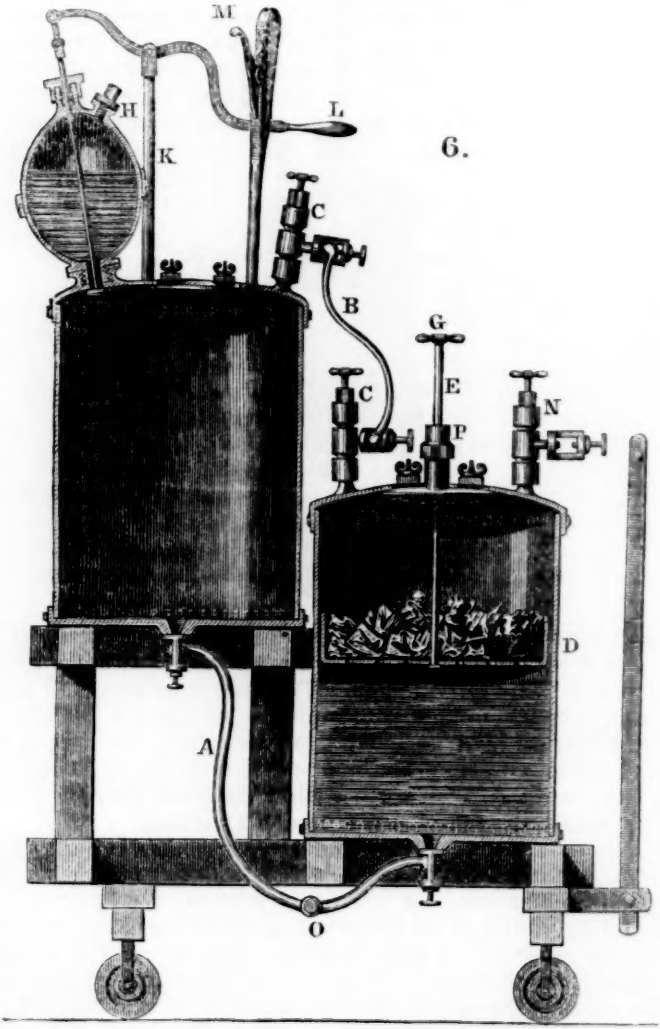

7.

Another apparatus for producing a supply of hydrogen, is represented in fig. 6. It consists of two similar vessels of boiler iron, each capable of holding forty gallons. They are lined internally with copper, being situated upon a wooden frame, so that the bottom of one is two-thirds as high as the top of the other. The upper portion of these vessels communicate by a leaden pipe, B, of about half an inch bore, furnished with a cock, while the lower portions communicate by another leaden pipe of a bore of 1½ inches.

The upper vessel is surmounted by a globular copper vessel, of about twelve inches in diameter, which, from its construction, renders it possible to introduce an additional supply of concentrated acid, while the apparatus is in operation, without reducing the pressure within the reservoir, by permitting the excess above the pressure of the atmosphere to escape. This object is accomplished as follows:—

The valve at the end of the rod, attached to the lever, L, being kept shut by the catch, M, the screw plug, H, removed, the acid is introduced through the aperture thus opened. In the next place, the plug being replaced, and the valve depressed by means of the lever and rod, so as no longer to close the opening, which it had occupied, the acid descends from the chamber into the cavity of the vessel beneath it. The valve is of course restored to its previous position as soon as the acid has effected its descent.

The lowermost vessel is furnished with a perforated copper tray, supported by a copper sliding rod, in a way quite analogous to that already described in the case of the copper reservoir. It is also sup-




6.

plied with zinc and its solvent in like manner, being made half full of the diluted sulphuric acid. Of course, on contact being produced between the zinc and its solvent, the generation of hydrogen will take place. So long as the communication between the upper portions of the two vessels is open, the gas will extend itself into both, occupying the whole of the upper vessel, and that half of the lower one which is

unoccupied by the liquid. But if, in this way, the pressure reaches to two atmospheres, as indicated by the gauge, on shutting the communication through the pipe B, the pressure in the inferior vessel will augment, that in the superior vessel remaining as before, but the liquid will consequently begin to pass out of the inferior vessel through the pipe A, and thus may lessen the contact between the acid and zinc, and finally suspend it altogether. Meanwhile the gas in the upper vessel being condensed to nearly half its previous bulk, the pressure will be nearly four atmospheres. It will, in fact, always be nearly double that which existed before the pipe, B, was closed.

In order that nearly the whole of the acid shall be expelled from the inferior vessel, the tray must be depressed till it touches the bottom of that vessel.

The pressure being four atmospheres at commencement, as soon as, by means of a pipe attached to the valve-cock, N, an escape of gas is allowed, the acid is forced again upon the zinc, and thus prevents a decline of pressure to any extent sufficiently to interfere with the process.

The gases may be used from a receiver in which they exist, in due proportion, safely by the following means:—

Two safety tubes are to be made, not by Hemming's process exactly, but as follows:

A copper tube, silver soldered, of which the metal is about the eighth of an inch in thickness, is stuffed with the finest copper wire, great care being taken to have the filaments straight and parallel. The tube is then to be subjected to the wire-drawing apparatus, so as to compress the tube on its contents until the draught becomes so hard, as that it cannot be pushed farther without annealing. The stuffed tube thus made is to be cut into segments, in lengths about equal to the diameter, by a fine saw. The surfaces of the sections are to be filed gently with a smooth file. By these means, they appear to the naked eye like the superficies of a solid metallic cylinder. Brass caps being fitted on these sections, they are to be interposed by soldering, at the distance of a foot or more, into the pipe for supplying the jet. Under these circumstances, the posterior section becoming hot, may allow the frame to retrocede; but the anterior section being beyond the reach of any possible combustion, and remaining cold, will not allow of the retrocession; and as soon as the flame passes the first section, the operator, being warned, will, of course, close the cock, and subject the posterior section to refrigeration before proceeding again.

But this plan of operating may be rendered still more secure by interposing a mercury bottle, or other suitable iron vessel, half full of oil of turpentine, between the reservoir and safety tubes, as in the arrangement of a Woulfe's bottle. A leaden pipe proceeding from the reservoir is, by a gallows screw, attached to an iron tube which descends into the bottle, so as that its orifice may be near the bottom. The leaden pipe communicating through the safety tubes with the jet-pipe, is attached to the neck of the bottle. Thus the gaseous mixture has to bubble through the oil of turpentine in order to proceed through

the safety tubes to the jet-pipe. If, while this process is going on, the flame should, by retrocession, reach the cavity of the bottle, exploding in contact with the turpentine, a compound is formed, which is, *per se*, inexplosive from the excess of carbonaceous matter. Meanwhile the shock, acting on the surface of the oil, drives it into the bore of the iron tube, and thus, both by its chemical and mechanical influence, renders it utterly impossible that the flame should reach the cavity of the reservoir.

---

### *Improvement in the Pin Manufacture.*

Pins are at present made for the most part of brass wire coated with tin to protect them from oxidation, for though pins have been also made, and may be still made for particular purposes, of iron and steel wire similarly coated, yet owing to the difficulty of coating the latter with tin, (arising from the small affinity which tin has for iron and steel,) it has been hitherto found impracticable to produce iron or steel pins of sufficient sharpness and smoothness to be suitable for general use, or applicable to any other than coarse fabrics.

A process has recently, however, been invented in France, and secured by patent in this country, (in the name of Mr. J. C. Robertson,) by which pins may now be manufactured of iron and steel equal to the best brass pins in point of smoothness, and far superior to them in respect of strength, sharpness, and tenacity.

The means by which this is effected may be described generally as consisting in giving the iron and steel pins a coating of copper previous to coating them with tin, the copper adhering readily to the iron or steel, for which it has naturally a strong affinity, and the tin combining with equal readiness with the superimposed copper; or in coating them with copper alone without any additional coating of tin.

The details of these improved methods of manufacturing pins of iron and steel wire, (so far as they differ from those of the methods hitherto pursued,) are described as follows, under the different heads into which the same practically divide themselves:—

*The Selection and Preparation of the Wire.*—The iron or steel wire employed should be very round, and, to protect it from rust, it should at the last drawing be lubricated by means of a sponge saturated with oil, placed between the draw-plate and reel. In all the subsequent stages of the manufacture care should also be taken to preserve the pins from oxidation by keeping them well oiled or greased.

*The Cleansing and Polishing.*—The wire being cut into pins, and these headed and pointed, all according to the usual methods, the pins are thrown into a revolving cylinder of wood, containing a bath of soap and water in a hot state. It is of the capacity of about nine gallons and a half, but should not contain more than about one gallon and a half of water, with about two ounces of soap dissolved therein, as this quantity will be sufficient for the treatment of about thirteen pounds and a half weight of pins at a time. The cylinder, when thus

charged, is made to revolve for about a quarter of an hour; at the expiration of which time the pins are found free from the oil with which they were previously coated, and also very much smoothed and polished by their rubbing one against the other.

*The Drying.*—The pins are next dried by transferring them to another cylinder partially filled with well-dried sawdust, (preferring for the purpose the sawdust of poplar wood,) and causing this cylinder to revolve for about ten minutes; or, instead of employing a cylinder of this description, the pins may be thrown into a bag or bags partially filled with the sawdust, and the requisite friction produced by swinging or rolling these bags about for the same length of time.

*The Copper Coating Bath or Mixture.*—Into a glass, or stone vase, the inventor puts about one and a half gallons of soft water, seven-tenths of a pound of sulphuric acid, $\frac{6}{100}$ lb. of salt of tin, $\frac{8}{100}$ lb. of crystalized sulphate of zinc, and 108 grains of pure sulphate of copper, and leaves this mixture to work for about twenty-four hours, so that the salts and sulphates may be properly dissolved. This is found to be on the whole the mixture best adapted for the purpose in view; but most of the ingredients mentioned may have others substituted for them, as, for example, any other acid or substance producing like effects may be used instead of the sulphuric acid, or the sulphate of tin may be substituted for the salt of tin, or any of the salts of copper or zinc used in place of the sulphates of copper or zinc.

*The Copper Coating Process.*—The mixture prepared, as last directed, is introduced into another revolving cylinder, and pins (about 13½ lbs. weight as before) are thrown into the midst of it. The cylinder is then caused to revolve for about half an hour, which serves at once to remove any verdigris from the pins, to impart a high polish to them, and to give a beginning to the copper coating process. At the end of the half hour, or thereabouts, $231\frac{6}{10}$ grains (more or less) of crystalized sulphate of copper of about the roughness of marine salt, and $150\frac{2}{5}$ grains of crystalized sulphate of zinc, (previously dissolved in soft water,) are added to the mixture in the cylinder, and the whole again agitated for about a quarter of an hour. The pins are by this operation not only completely coated, but acquire a very considerable degree of polish. The copper liquor is then drawn off, and the pins twice suffused with cold water, while the cylinder is kept rotating at the rate of about one turn a minute. The pins are then taken out and thrown into a wooden tub containing hot soap and water, after which the tub is hermetically closed by putting on a rimmed cover, and making it fast by hooks and eyes. The pins are now well shaken, by overturning the tub and raising it up again, some thirty or forty times, more or less. The contents of the tub are then emptied into a wooden strainer having a perforated bottom of tinned plate iron; and when the soap and water has drained from the pins, the latter are placed, while yet wet, in a revolving cylinder, containing well-dried sawdust, (using by preference, as before, the sawdust of poplar wood,) or well-dried bran freed from flour. The pins are now dried by turning the cylinder for from five to six minutes, at the expiration of which time they exhibit a very beautiful copper appear-

ance, and may be used in this state without tinning, if thought desirable.

A considerable portion of the coppering ingredients may be saved after each operation by allowing the mixture to settle, then drawing off the supernatant liquor, and adding thereto 386 grains of sulphuric acid to bring it up to a strength sufficient for subsequent use.

*Tinning and Blanching.*—The pins are tinned and blanched in the ordinary manner, and by the ordinary processes used for those of brass wire, that is, by laying them on plates of very thin tin placed one above another, in a tinned copper boiler containing a solution of about 4⅔ lbs. of crude tartar, or cream of tartar, (preferring the latter,) in about twenty-two gallons of water, and then setting the whole to boil for about twelve hours. The tartar solution should be prepared at least twenty-four hours previously, and left to work for that time, in order that the ingredients may be thoroughly dissolved and intermixed. About 4⅔ lbs. of cream of tartar is the minimum quantity which should be used, and the brilliancy and celerity of the tinning will increase in proportion to the increase of the quantity employed.

The pins are then taken out of the boiler and dried in a revolving cylinder or leathern bag, as before explained, after which they are ready for use. Lon. Mec. Mag.

---

## *Explosion of a Blast Pipe.*

An explosion of a peculiar and unfortunately fatal nature, lately occurred at the works of Messrs. Losh, Wilson, and Bell, near Newcastle. It appears that one of the underground pipes of the blowing engine was in a leaky state, and the air thus escaping, forced its way into the ash-pit of one of the puddling furnaces near it. The carbonic oxide and carbonic acid gas thus generated, passed through to one of the offices connected with the establishment, and suffocated two of the workmen. Upon the discovery of this casualty, as the matter was undergoing an investigation, the blast regulator was exploded by a light carried by one of the men. This second accident caused the death of one man, and wounded several others. We subjoin the particulars of the case, as given by Mr. Bell, one of the partners of the firm.

"About half-past 6 o'clock, it was discovered that a man named David Davies, and a boy of the name of Spearman, were suffocated in an office constructed for the use of our workmen: and it was only after considerable difficuly, and great exposure to danger, that the bodies of these unfortunate individuals were extricated by the intrepid conduct of some of our men, where everything was done to endeavor to restore them to life, but in vain. To prevent the possible recurrence of such an accident, immediate measures were taken by the men to ascertain the cause of the disaster, with a view to its prompt removal; and then it was that it was ascertained, from some cause or other, that a joint of an underground pipe, of about four inches in diameter, communicating with our main blast-pipe, which is

about three feet in diameter, had been leaking, and thus occasioning a loss of blast to a certain extent; which, making its way underground to the ash-pits of some of our puddling furnaces in its neighborhood, had caused a somewhat increased combustion of any ashes that might be, for the time being, lying under the bars. The heat thus generated had heated through the brick lining of the ash-pit, and communicated ignition to the small stratum of ashes on which the pavement is laid, as well as to a minute quantity of ashes that had got accidentally mixed with the clay, in the construction of the furnaces. The carbonic oxide and carbonic acid gases thus formed, had found vent by penetrating towards the office in which the deaths of Davies and Spearman occurred, and no doubt had suffocated them, as their bodies bore all the usual traces where asphyxia is the cause of death. The blast-engine being stopped, an endeavor was made to separate the four-inch pipe alluded to from the main blast-pipe; but this being impossible, or at least difficult, it was determined to proceed to the regulator (an iron vessel about 20 feet long and 6 feet diameter, shaped like a boiler,) where, by opening the manhole door, access might be had to the point of junction of the four-inch pipe with the main, and a secure stopping put in so as to prevent the possibility of any blast reaching the vicinity of the puddling furnaces or office. The manhole door being removed, William Short, the head smith of the establishment, and an intelligent man, smelling foul air, desired one of his assistants to keep off the opening with the lamp; which was done. In about three minutes, and while they were standing close to the regulator, Short heard a rushing noise in the blast-pipe and regulator; and instantaneously succeeding it, a terrific explosion took place, which threw him down. Fortunately he sustained only some very trifling injury; but Robert Rogers, a millwright, who was standing close to him, and immediately opposite to the manhole, was blown over a wall close behind them, in such a manner that to have reached his position the unfortunate man must have been projected very many yards into the air. He was so sadly mutilated that death must have been instantaneous. The explosion, following the main blast-pipe, was conducted by it to a supplementary blowing engine, great part of which it shattered to pieces: and one of the fragments of this, striking a young lad of the name of Maughan, dangerously fractured the bones of his face, and broke his arm: while another, taking a contrary direction, struck a man named Tyson, and fractured his leg. Robert Rogers is the only one among the killed who is married: and he, I regret to say, has left a wife and three children. The next morning, on visiting the scene of the accident, I was surprised to find how complete the destruction of the receiver had been; for of it not one-tenth remained on its seat, though it was very strongly held down. One large piece was thrown over all the offices (all the windows of which were blown-out); another was projected so high into the air, that on falling on some railing, 130 yards off, it was found impaled; a third was found on the top of the inn, 200 yards distant, at an elevation of 20 yards above its original level. Besides this, many yards of the blast-pipe were torn like so much paper; and frag-

ments of it, and of the regulator, were found in various directions in the works. The cause of this deplorable explosion I take to be this: As soon as the manhole door was removed, a current of air has been put in motion along the main blast-pipe (owing, very probably, to the high wind blowing at the time), which had caused an influx of carbonic-oxide gas through the four-inch pipe from the puddling furnaces already mentioned; and this becoming mixed with the atmospheric air in the blast-pipe, would form a highly explosive mixture. How ignition was communicated, I cannot say; but I am of opinion that some red hot ashes in the ash-grates of the puddling furnaces is the probable source. It seems almost incredible that the comparatively small quantity of incandescent ashes should be able, in so short a time, to have generated sufficient carbonic oxide gas, and still more incredible that it should have entered in sufficient quantity into the blast-pipe to have caused such tremendous destruction as it did; but as all the blast-pipes in the vicinity of the blast-furnaces (the only other possible source of gas) are uninjured, I am compelled to come to the conclusion that the source I have mentioned was the true one of the explosion. Considering the quantity of material projected in various directions among our work-people, it is a miracle that many more were not sacrificed, I am glad to say, the injury (which will not exceed £200 or £300) is entirely among machinery not in present use, and will, therefore, not prevent our workmen following their usual avocations."

Glasgow Prac. Mec. & Eng. Mag.

---

### *On the Iron Manufacture of Great Britain.*

Mr. G. R. Porter (of the Board of Trade) presented an elaborate report on this subject to the late meeting of the British Association, which he had prepared at their request. Having called attention to the enormous demand for iron consequent on the general and simultaneous construction of railways in England, on the Continent, and in India, he said it was important to consider how that demand may be met, and also how, on the cessation of that demand, which must be temporary to a great extent, the ruinous depreciation of capital and suspension of employment, consequent on the change, may be averted. In 1788, the whole quantity of pig-iron made in England and Wales, amounted to no more than 61,300 tons; of which 48,200 were made with coke of pit-coal, and 13,100 from charcoal; in the same year, the amount raised in Scotland was 7000 tons. In 1796, the quantity, owing to Watt's improvement of the steam engine, was nearly double, being—

| | |
|---|---|
| England and Wales, . . . | 108,993 tons. |
| Scotland, . . . | 16,086 " |
| Total, . | 125,079 tons. |

Ten years later—viz. in 1806—when it was proposed to tax the production of iron, an inquiry was made, and the production was found to have more than doubled in this decennial period, being—

| | |
|---|---|
| England and Wales, . . | 234,966 tons. |
| Scotland, . . . | 23,240 " |
| Total, . | 258,207 tons. |

In 1823, the quantity had risen to 482,066 tons; and in 1830, it was further increased to 678,417 tons. But since 1830, in consequence of the introduction of the hot-blast by Mr. Neilson, of Glasgow, rapid improvements have been made, and a most important saving of fuel effected. The results were thus stated:—In 1829, using coke and cold air, each ton of iron required for its production 8 tons 1 cwt. 1 qr. of coal. In 1830, using coke and heated air, each ton of iron consumed in its production 5 tons 3 cwt. 1 qr. of coal. In 1833, using raw coal and heated air, each ton of iron consumed in its production 2 tons 5 cwts. 1 qr. of coal. The saving in fuel is thus seen to amount to 72 per cent.; and, in Scotland, the production of iron has risen from 37,500 tons in 1830 to nearly 500,000 tons in the last 12 months. There exists a prejudice against the hot-blast iron which is gradually abating; and a similar prejudice long prevented the use of the black-band ore, the value of which was discovered by Mr. Mushett, so far back as 1801. In 1836, every iron-work in Great Britain was visited by M. F. Le Play, chief engineer to the Paris Board of Works; and he estimated the amount produced that year at 1,000,000 of tons. In 1840, Mr. Jessop found that there were 402 furnaces in England and Wales, in which 82, or one in 5, were out of blast; and out of 70 furnaces 6, or 1 in 11, were out of blast. The quantity of iron made, in 1840, was 1,343,300 tons; but, in consequence of the commercial depressions, this fell to 1,046,428 tons in 1842, being a depreciation of 22 per cent. He next directed attention to the effect of railways on the price of iron. In 1836 and 1837, Parliament passed 77 railway bills, of which 44 were for new lines, and the aggregate of extent about 1200 miles, requiring a production of more than 500,000 tons of iron. The price of bar iron which had been £6 10s. per ton in 1834, rose to £7 10s in 1835, and in 1836 to £11; but in 1837, the railway speculation had so far subsided, that only 15 Acts for new lines were passed from 1838 to 1843, the price of iron fell more rapidly than it had risen, and, during this period, iron could be sold with difficulty at less than half the price it commanded in 1836. The average price of iron at Glasgow, in 1844, was £2 5s. 6d. per ton; in March, 1845, it rose to £5; and in May to £5 10s.; this rise in price of 175 per cent. gave such stimulus to production, that the make of pig-iron, in Scotland, for the first six months of this year, was 260,000 tons, or at the rate of 520,000 tons per annum: the production having been doubled since 1840. It is the opinion of the iron-masters that, since 1840, nearly all the increased production of iron in the kingdom has been drawn from Scotland. It appears that the demand, created by the new railways, has stimulated every establishment to its utmost limits of production. But, in order to add materially to the make of iron, a great many circumstances must concur. One of the chief difficulties arises from the workmen: skill is necessary, and the number of those properly trained is so limited, that they make demands for an enormous and disproportionate increase of wages on

the first appearance of prosperity. Thus the cost of production seems to have more than kept pace with the rise of price. From this, combined, perhaps, with other causes, the amount of production in England, for 1845, was only 917,500 tons, being 238,000 tons less than the production of 1840. From comparing several returns, it is clear that we have no reason to dread a failure of material—some valuable and extensive fields of black-band ore having been recently discovered in Wales; but it seems not improbable that the Staffordshire iron-works will soon experience a deficient supply of coal. A new source of supply has been found in the refuse and waste of the lead mines of Weardale. The rider of the lead ore is a true carbonate of iron, yielding from 25 to 40 per cent. A small blast furnace has been erected at Stanhope, for smelting this rider, and pig-iron of a strong and excellent quality has been produced. In consequence of this success, the company has commenced the erection of very extensive smelting works, near Walsingham. The difficulty then arises in the supply of labor. It is hopeless to stimulate the exertions of the persons already employed. They are naturally ready enough to exact higher rates of wages when the demand for their labor becomes more urgent; but, succeeding in this, they prefer to obtain the same amount of earnings, with higher rates of wages, to the security of greater gains by the exertions of even the same amount of toil; so that a greater urgency on the demand may be, and frequently is, accompanied by a lessened production. During the period of depression, the low price of iron led to its being extensively applied to various purposes of construction in civil and naval architecture. On the subject of iron ships, Mr. Porter entered into some calculations to show their economy; but the subject will be found more fully discussed in our report of the paper read by Mr. Fairbairn before the meeting of the British Association in Glasgow, in 1840. Up to the beginning of the present century, nearly two-fifths of all the iron used in this kingdom was imported from the north of Europe; but, in 1806, this proportion had fallen to one-eighth, and foreign iron is now only imported for the manufacture of steel. Our exports, on the contrary, have so increased as to become an object of national importance.—

| | | | | | | |
|---|---|---|---|---|---|---|
| In 1827 we exported | 92,313 | tons, | declared value | | £1,215,561. |
| In 1845 " " | 351,278 | " | " | " | " | 3,501,895. |

The increase of our exports appears to be contingent on a reduction of price, and must, therefore, be materially affected by variations in the cost of production. Should the new railways stimulate a much larger production of iron, the quantity produced will greatly exceed the demand so soon as those railways are completed; and then prices will fall, perhaps, to a lower point than has ever yet been witnessed. This will, probably, cause iron to be applied to many new purposes, and particularly to the construction of ships, fire-proof houses, and frame-work houses for export to new settlements. All this, however, must be the work of time; and it seems but too probable that, in the meanwhile, our iron-masters will have to undergo a somewhat lengthened season of adversity—for the enduring of which they are, in a measure, prepared, from former experience. Min. Jour.

*Extract from Observations on the Tides, deduced from Tidal Observations made in Plymouth Dockyard, from August, 1831, to September, 1833.*

When the writer began his paper on the tides in 1832, he had a self-registering tide-gauge set up in Plymouth Dockyard, by means of which tide observations might be obtained with tolerable accuracy. He had noticed, when serving in the Mediterranean Sea, that fine settled weather, a high barometer, and a low sea-level, were attendant circumstances; and he ascribed the fluctuations in the level of the Mediterranean to fluctuations in the pressure of the atmosphere. It was considered that changes in the water's surface, arising from fluctuations in atmospheric pressure, might be disentangled from tidal observations, provided the *correct sea level* could be found. This was a subject on which there were doubts. It was considered by Newton, Lalande, and others, that the natural level of the sea was at a point two-thirds below high-water mark, and one-third above low-water mark at spring tides; but the height of spring tides differing among themselves, it is evident that each would give a different *sea level*, and *all* could not be correct. The writer, from some rough observations he had made, considered it more than probable that *every tide* ranged as much above as below the medium level of the sea. The tide-gauge was principally intended to determine these important points. We have already premised that the waters of the ocean would assume a permanent curvature, and their surface would preserve a constant height, unless acted on by external forces; but the surface of the sea being raised by the moon's attraction when in the meridian, and depressed by her when in the horizon, it was considered that these elevations and depressions might be equal, like the elevations and depressions of ordinary waves. On the principle, too, that action and re-action are equal and opposite, the waters of the ocean, when drawn upwards by any force, should descend below their medium level when that force ceased to act. Now a careful discussion of about 2400 tide observations made in Plymouth Dockyard, between 1831 and 1833, has fully established the important fact that the surface of the sea at Plymouth is at half-flood or half-ebb always at the same height, whether at spring-tides or neap-tides, and that every tide ranges as much above as it falls below the half-tide mark, *which is a fixed point*, and may be looked upon as that height which the waters of the ocean would assume if not acted on by solar or lunar influence.

The Lords Commissioners of the Admiralty having communicated to the Royal Society a series of tide observations made in the Royal Dockyards of Portsmouth, Plymouth, and Sheerness, in the years 1831, 1832, and 1833, the president and council caused them to be printed, and, through the kindness of a friend, I was furnished with a copy. It appears, by an examination of these tide observations, that the same law obtains at Portsmouth and Sheerness, and that the medium sea-level is subject to slight changes from atmospherical agen-

cies, which have not been registered in the tidal observations already alluded to.

In connexion with this subject, it may be noticed that about the year 1792, Mr. Graeme Spence, a marine surveyor, was employed by government in surveying the Scilly Islands; he was directed to pay particular attention to the tides among these islands; he accordingly made and recorded a vast number of tidal observations, which, being arranged in a tabular form, were printed by order of the Admiralty for the use of the Royal Navy. Mr. Spence appears to have been a very correct observer of natural phenomena: he set up tide-gauges in the different sounds and channels among the Scilly islands for the purpose of ascertaining the rise and fall of the water for *every hour* during the ebbing and flowing of extraordinary, ordinary, and neap tides throughout the year; from the observations he has left us, it appears that in every sound of Scilly, there is *always* the same depth of water at half-flood, or half-ebb, and that every tide, whether *spring* or *neap*, rises as much above as it falls below the *half-tide level*. It does not appear that Mr. Spence noticed this interesting circumstance, inasmuch as no mention is made of it in the work itself; and it was in October, 1836, that the writer of this article, in looking into Mr. Spence's tables, discovered proofs so corroborative of his own observations. Let us pause to inquire what advantages may be derived from a knowledge of the fact, that there is a point and a time of every tide, when the surface of the sea is at the same height. In the first place, any addition to our stock of knowledge enables us to extend our inquiries, and to explain many apparent anomalies in a satisfactory way.

The natural level of the sea being once known, we are enabled by means of tide observations to ascertain how much the surface may be raised by particular winds. We obtain a zero from which to compute the height of objects on land, and the *depths* of soundings at sea. We obtain a point where the mean pressure of the atmosphere should be measured; where the oscillation of pendulums should be counted, in order to compare the force of gravity in different parts of the world. The medium level of the sea being known, under the mean pressure of the atmosphere, we are enabled to determine in what proportion the surface of the sea should rise when the mercury descends in the barometer, and *vice versa;* and, finally, when the weight of the superincumbent column of air is known, the force and direction of the wind given, we can predict the actual height of future tides. *Ex. gratiâ:* The range of an equinoctial spring tide at Plymouth, *may* be 19 feet 6 inches; this *may* happen when the barometer is as low as 28: and when the barometer is very low a gale of wind *may* blow from the south. Now a gale of wind from the south will raise the water 8 inches in Hamoaze—a *sudden* fall of the barometer = 2 inches will be accompanied by a rise of the water's surface = 3 feet 4 inches, so that the natural sea level would be raised 4 feet. If to this be added half the range of the tide as resulting from solar and lunar attraction, we shall have 4 feet $+\frac{19\frac{1}{2}}{2}$ = 13 feet 9 inches as the height

to which the waters would be raised above their medium level under the conditions assumed; namely, 25 feet 11½ inches at the entrance of the North Dock in Plymouth yard. Now this is about the height which the tide reached in the storm of November, 1824. *Engineers should understand these matters before they determine the height of sea walls and other barriers erected to keep out the tides!!*

If it be known that there is a certain depth of water over any shoal at half tide, a pilot may be sure of finding the same depth at every other half tide under similar circumstances. For example, spring tides near the mouth of the Thames rise 18 feet, and ordinary neaps about 9 feet; and since there is about 12 feet water over the flats between the Queen's and Nob channels at low water spring tides, there will be 21 feet at half flood: and since the water is always at the same height at half tide, there will be 21 feet over the flats at half flood or half ebb during neap tides also. If the range of a neap tide be only 9 feet, there would be $21 - \frac{9}{2} = 16\frac{1}{2}$ feet over the flats at *low water* neap tides. These reasonings apply on *every coast*, and all pilots ought to know them; but few indeed seem to be sensible of the important fact, that in all harbors and channels, and over all shoals, there is an equal depth of water at every half tide, when the atmosphere is in its ordinary state. Lon. Mec. Mag.

---

*On the Origin of the Coal of Silesia, by Prof.* Goeppert, *of Breslau.*

This paper was an abstract of an essay which received the prize offered by the Society of Sciences of Holland, at Haerlem, in 1844. Prof. Goeppert remarks, that hitherto few well-preserved plants had been obtained from the coal itself, but its composition had been inferred from the plants which lie in the associated shales. In the coal-fields of Upper and Lower Silesia, which yield four millions of tons a-year, he had met with extensive layers, in which the plants were so well preserved, that he could distinguish coal formed from Sigillariæ from that formed by Araucariæ or Lepidodendra. In most instances the bark alone was preserved—the specimens being flattened; but the Araucariæ, being much harder than the rest, often retained their woody tissue and medullary rays. The species, 80 in number, were found to be differently grouped in the various coal strata, and also under different conditions; and this, with the delicate preservation of the ferns, the multitude of upright stems, of which 200 have already been observed, and the uniform thickness of the strata over a space of many miles, are considered by the author a proof of tranquil deposition on the present localities. The Silesian coal strata are from 30 to 60 feet thick; a larger portion of which M. Goeppert supposes to have accumulated after the manner of *peat*,—during the lapse of time. He has ascertained that, by keeping vegetables in boiling water for three months or a year, they are converted into brown coal *(lignite)*, and, by the addition of a small quantity of sulphate of iron, a salt which occurs commonly in coal, acquire, at last, a totally black, coal-like condition.—Sir R. I. Murchison expressed his readiness to receive